BENJAMIN J. CAYETANO
GOVERNOR OF HAWAII

MICHAEL D. WILSON, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTY
GILBERT COLOMA-AGARAN

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
BOATING AND OCEAN RECREATION
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

**STATE OF HAWAII**
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT
P. O. BOX 373
HONOLULU, HAWAII 96809

FEB - 8 1995

Mr. Lynn G. White
Vice President and General Manager
Puna Geothermal Venture
P.O. Box 30
Pahoa, Hawaii 96778

Dear Mr. White:

**Annual Mechanical Integrity Test Reports**

We have reviewed your annual mechanical integrity test reports for injection wells KS-1A, KS-3 and KS-4, submitted December 5, 1994. We concur with your findings that the subject wells show good mechanical integrity.

Sincerely,

MANABU TAGOMORI
Manager-Chief Engineer

JF:ek
c: Dept. of Health

JOHN WAIHEE
GOVERNOR OF HAWAII

KEITH W. AHUE, Chairperson
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
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LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

REF:WL-LC

APR 15 1993

Ms. Jennifer Shishido
Administrator
State of Hawaii
Division of Occupational Safety and Health
Department of Labor and Industrial Relations
830 Punchbowl Street
Honolulu, Hawaii 96813

Dear Ms. Shishido:

Use of Explosives for Plugging and Abandonment of Wells KS-8, KS-1 and KS-2

In accordance with the Department of Land and Natural Resource's Administrative Rules, and under a permit granted by our department, Puna Geothermal Venture (PGV) began plug and abandon operations on the KS-8 well on April 13, 1993. The operations will include utilizing explosive perforating charges deep within the well. In the interest of safety and efficiency, PGV plans to conduct the abandonment operations in a continuous, 24-hour per day basis.

It is our understanding that PGV has requested a variance from your Division for use of explosives on a 24-hour basis. This is to inform you that the Department of Land and Natural Resources has no objection to your granting such a variance. PGV will need this variance to include wells KS-1 and KS-2 for subsequent operations.

Very truly yours,

KEITH W. AHUE

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
DIVISION OF WATER AND LAND DEVELOPMENT
P. O. BOX 373
HONOLULU, HAWAII 96809



# FACSIMILE TRANSMITTAL PAGE

Please deliver the following pages to:

Name: TOM KIZIS

Company: PGV

From: MANABU TAGOMORI

Date: 4-16-93 Time: ______

Message: LETTER TO JENNIFER SHISHIDO
RE: EXPLOSIVES

Total number of pages (including Transmittal Page) 2

* * * * * *

If you do not receive all of the pages legibly, please call back: (808) 587-0220 LISA

Sending Facsimile Number: (808) 587-0283

Receiving Facsimile Number: (808) 965 7254

MEMORY TRANS REPORT

( APR 16 '93 07:50AM )

:STATE/DLNR/DOWALD

| FILE NO. | FILE TYPE | DEPT. CODE | PAGES | RESULTS | GROUP | REMOTE TERMINAL IDENTIFICATION |
|---|---|---|---|---|---|---|
| 185 | SEND IMMEDIATE | | 2/2 | OK | | 919657254 |

THIS FILE HAS BEEN CLEARED.

# *PUNA GEOTHERMAL VENTURE*

*A Hawaii Partnership*

| Post-It™ brand fax transmittal memo 7671 | # of pages ▸ 2 |
|---|---|
| To Mr. Tagomori | From Tom Kizis |
| Co. DLNR | Co. PGV |
| Dept. | Phone # 965 6233 |
| Fax # 587 0283 | Fax # 965 7254 |

April 14, 1993

Mr. Manabu Tagomori
Division of Water and Land Development
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

SUBJ: PLUG AND ABANDON OPERATIONS (KS-8/KS-1/KS-2)

Dear Manabu,

Under a permit issued by the Department of Land and Natural Resources (DLNR), Puna Geothermal Venture (PGV) began plug and abandon operations on the KS-8 well on April 13, 1993. The operations will include utilizing explosive perforating charges deep in the well. For reasons of safety and efficiency, PGV plans to conduct the abandonment operations in a continuous 24 hour operation. Because of this, some or all of the perforating work may be done at night. For this reason, PGV has requested from the Department of Labor and Industrial Relations, Division of Occupational Safety and Health (OSHA) a variance to use explosives on a 24 hour basis.

As a condition of issuing the variance, OSHA has asked for a letter from DLNR acknowledging your understanding of PGV's proposed operations and stating that you have no objection to the requested variance.

PGV is asking that the variance apply to plug and abandon operations for wells KS-1 and KS-2, which will commence immediately upon completion of well KS-8. We anticipate these operations to be complete in approximately eight (8) weeks.

Thank you for your prompt consideration of this matter. If you or your staff have questions, please call.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

MEMO: 21717.TK
FILE: KS-08

wl

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EMD / SDWB

April 13, 1993

APR 20 A7:47

Mr. Steven E. Morris
Vice President and General Manager
Puna Geothermal Venture
P. O. Box 30
Pahoa, Hawaii 96778

Dear Mr. Morris:

SUBJECT: PUNA GEOTHERMAL VENTURE
UNDERGROUND INJECTION CONTROL (UIC)
UIC APPLICATION NO. UH-1529

The Department of Health has completed its review of the injection test results for reinjection well KS-4, and has completed the review of the 5-inch liner nitrogen pressure test results for KS-3. Based on the test results, the Department has determined that the conditions to operate KS-3 and KS-4, along with previously authorized KS-1A, as primary reinjection wells have been satisfied. Therefore, you are hereby granted approval to operate three (3) reinjection wells: KS-1A, KS-3, and KS-4; under the terms and conditions of the enclosed permit.

Your facility and reinjection wells have been assigned the following identification numbers:

**UIC Permit No. UH-1529**
**Facility ID No. 8-2883.01**
**Well No. KS-1A, KS-3 and KS-4**

Please refer to these identification numbers, along with your UIC permit number, in all future correspondence with this office.

Failure to comply with the terms and conditions of the permit will constitute a violation of the permit. Any person who violates the permit requirements or any provision of Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control, shall be subject to the penalties provided in Section 340E-8, Hawaii Revised Statutes.

If you have any questions regarding your permit, or the UIC Program, please contact Chauncey Hew of the Safe Drinking Water Branch at 586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258.

Sincerely,

Thomas E. Arizumi

THOMAS E. ARIZUMI, P.E., Chief
Environmental Management Division

CH:kt

Enclosure: UIC Permit

c:
1. Glenn Tomori, SDWB Sanitarian, Hilo (w/encl. of Permit)
2. Norman Hayashi, Planning Department, County of Hawaii (w/encl. of Permit)
3. Keith Ahue, DLNR (w/encl. of Permit)
4. Mufi Hannemann, DBEDT (w/encl. of Permit)
5. Clarence Tenley, EPA (w/encl. of Permit)

Permit No. UH-1529

AUTHORIZATION TO OPERATE UNDER THE
UNDERGROUND INJECTION CONTROL PROGRAM

In compliance with the provisions of the Safe Drinking Water Act, Chapter 340E, Hawaii Revised Statutes (HRS), as amended, and Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control;

PUNA GEOTHERMAL VENTURE

is authorized to operate a Class V, Subclass E, geothermal reinjection well system consisting of three (3) reinjection wells; known as geothermal wells Kapoho State 1A (KS-1A), Kapoho State 3 (KS-3), and Kapoho State 4 (KS-4):

| Reinjection Well No. | Operational Status | Located on Well Pad | Approx. Well Head Elevation Above Mean Sea Level |
|---|---|---|---|
| KS-1A | Primary Injector | A | 617 feet |
| KS-3 | Primary Injector | E | 618 feet |
| KS-4 | Primary Injector | E | 618 feet |

and having the specifications as listed in Figure No. 1, Figure No. 2, and Figure No. 3, respectively; to reinject the geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal noncondensible gases which are produced during the operation of the well field and power plant; and the intermittent inclusion of reinjection supplement water; back into the geothermal reservoir at an interval between the approximate depths of 3,900 feet and 7,300 feet;

located at the facility's address of 14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778; at Tax Key Number, 3rd Div. 1-4-01:2 and 19; at the approximate well pad coordinates:

Well Pad A: Latitude 19° 28' 49" N and Longitude 154° 53' 35" W;
Well Pad E: Latitude 19° 28' 41" N and Longitude 154° 53' 40" W;

in accordance with monitoring requirements and other conditions set forth in Parts I, II and III hereof.

This permit will become effective upon issuance.

This permit and the authorization to operate the reinjection wells will expire at midnight, October 20, 1995.

Issued on the 7th day of April 1993.

Thomas E. Arizumi

(For) Director of Health

PERMIT ISSUED
Date APR 7 1993

A. THE OPERATION OF THE REINJECTION WELLS SHALL BE LIMITED TO:

1. Operational Status

Reinjection Wells KS-1A, KS-3, and KS-4 are herein recognized as primary reinjection wells that comprise the reinjection well system to service the operations of the power plant.

2. Injectate Characteristics

The reinjection of geothermal fluids consisting of geothermal brine, geothermal steam condensate, geothermal noncondensible gases, chemical additions for well casing corrosion and scale control, and reinjection supplement water, that may include the chemical parameters as listed in Table No. 1 as being representative of the geothermal fluid.

3. Reinjection Limitations

(a) Reinjection Pressure:

The reinjection pressure as measured at the well head shall not exceed 500 psi gauge or the fracture pressure of the receiving formation, whichever is less.

(b) Reinjection Quantity and Rate:

The reinjection quantity and rate shall be commensurate with the production of up to twenty-five (25) megawatts, net power.

The reinjection rate shall be limited to a total of approximately 675,000 lbs./hr., or to a rate commensurate with the reinjection capacity of the reinjection wells, whichever is less. The approximate composition of the injectate based on 675,000 lbs./hr. is:

| | |
|---|---|
| Steam Condensate | 505,816 lbs./hr. |
| Brine | 128,250 lbs./hr. |
| Supplement Water and/or Brine from the Storage Pits | 39,751 lbs./hr. |
| Total Noncondensible Gases | 1,183 lbs./hr. |
| Total | 675,000 lbs./hr. |

PERMIT ISSUED
Date APR 7 1993

(c) Concentrations of the Injectate:

The concentrations of the chemical parameters of the geothermal fluid listed in Table No. 1 are recognized as being variable and peculiar to the geothermal resource and the processes of geothermal energy production. Therefore, concentrations as such, for the purpose of setting maximum chemical levels, are not listed in this permit; however, chemical analyses are required as detailed in Part I, Section B of this permit.

(d) Chemical Additions:

To maintain the integrity and function of well casings, the use of chemical additions to the reinjection wells and production wells are hereby acknowledged and listed. The chemical ingredients of the products are listed in Table No. 2.

| Product Name | Function | Location of Use |
|---|---|---|
| Amersite (R) 2 | Corrosion Inhibitor | Reinjection Well |
| Wrico Oxy 11 | Corrosion Inhibitor | Reinjection Well |
| WPD 11-306 (Tm) | Corrosion Inhibitor | Reinjection Well |
| West R-322 | Corrosion Inhibitor | Production Well |
| Midland 203 | Oxygen Scavenger | Reinjection and Production Well |
| Millsperse (R) 802 | Antiscalant | Reinjection Well |
| Sodium Hydroxide | pH Adjustor | Production Well |

(e) Prohibited From Reinjection:

There shall be no reinjection disposal of fluids other than the geothermal fluid, reinjection supplement water, and chemical additions for the control of corrosion and scaling as described in this permit. Furthermore, there shall be no reinjection disposal of:

- Hazardous wastes as defined in Title 40, Code of Federal Regulations (CFR), Part 261;

- Domestic wastewater as defined in Hawaii Administrative Rules, Title 11, Chapter 62, "Wastewater Systems"; and

- Any designed chemical addition to the geothermal fluid unless recognized and approved by this permit.

PERMIT ISSUED
Date APR 7 1993

B. MONITORING AND REPORTING REQUIREMENTS:

1. Injectate and Reinjection Well Monitoring

(a) Samples and measurements taken as required herein shall be representative of the volume and nature of the geothermal fluid and reinjection supplement water.

Detailed records of the operation of the reinjection wells shall be kept by the operator. Records shall include, but not be limited to, the following information:

(1) Type of injectate.
(2) Quantity of injectate.
(3) The method of reinjection.
(4) The rate of reinjection.
(5) Reinjection pressure for wells situated in caprock areas overlying volcanic aquifers under artesian pressure.
(6) The exact date and time of the measurement.
(7) The person(s) who performed the measurement.
(8) The dates the analyses were performed.
(9) The person(s) who performed the analyses.
(10) The analytical techniques or methods used.
(11) The results of all required analyses and permit limits.

(b) A daily record of the injectate quantity being discharged into the reinjection wells shall be maintained. Injectate quantity recordings shall be continuously made with the use of instruments that directly measure and record the flow of the injectate.

(c) A continuous recording of the reinjection well head pressure and any gas blanket pressure shall be maintained. Pressure recordings shall be documented on a graphical chart, such as a strip chart or circular chart, that shows the relationship between pressure and elapse time. The pressure recordings shall be maintained whether or not the reinjection well is in use. The pressure recordings shall distinguish between the time periods of use and nonuse, if any.

(d) When reinjection supplement water is being used, a record of the reinjection supplement water quantity being discharge into the reinjection wells shall be maintained. The recordings shall be continuously made with the use of instruments that directly measure the flow of the supplement water.

(e) A record of the amount and type of chemical additions being used as specified in Part I A. 3. (d) shall be maintained. The record shall account for the daily, weekly and monthly consumptive rates. A summary report shall be submitted to the Department every thirty (30) days (monthly) showing the consumptive figures and describing the points of application within the geothermal fluid flow system.

PERMIT ISSUED
Date APR 7 1993

(f) Representative grab samples (three types) of the injectate shall be collected from a collection point to be established by the facility and approved by the Department. The collection and analysis of the samples shall be conducted by a laboratory which has been approved by the Department. If the laboratory is unable to perform the sample collection, the Department may allow the facility to collect the sample under the direction of the laboratory. All samples shall be collected, preserved, and documented in accordance with EPA or EPA equivalent standards. The falsification, fabrication, or tampering of the samples, chain of custody form, or analytical results shall be a violation of this permit. Methods of analysis shall be as stated herein or approved by the Department. The frequency of sample collection and the type of analyses are as described:

Type I Sample:

(1) Type I samples shall be collected and analyzed at least once every 30 days.
(2) Type I samples shall be analyzed for the chemical parameters listed in Table No. 1.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type II Sample:

(1) Type II samples shall be collected and analyzed at least once every 90 days in conjunction with Type I samples.
(2) Type II samples shall be analyzed for Ignitability, Corrosivity, Reactivity, and Method 1311: Toxicity Characteristic Leaching Procedure (TCLP) as described in 40 CFR, Part 261, Appendix II. Reference is hereby made to Table No. 3 which lists the chemical parameters for which the analysis shall be conducted under Method 1311. Regulatory levels of the chemical parameters are listed for reference.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type III Sample:

(1) Type III samples shall be collected and analyzed at least once every 90 days in conjunction with Type I and Type II samples.
(2) Type III samples shall be analyzed for volatile organic compounds as described in 40 CFR, Part 136, Appendix A, Method 624. Reference is hereby made to Table No. 4 which lists the chemical parameters for which the analysis shall be conducted under Method 624.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

PERMIT ISSUED
Date APR 7 1993

(g) The collection of Type II and Type III samples shall be witnessed by the Department. The permittee shall notify the Department at least seven (7) days prior to the date of sample collection for this phase of analysis. Any Type II and Type III samples that are collected without the acknowledgement and inspection by the Department will not serve to comply with the monitoring and reporting requirements of this permit.

(h) A periodic recorded inspection of the reinjection wells at least once per 7 days shall be conducted by the facility. The inspection shall include the recordation of the operational status of the reinjection wells to detect any deterioration of the reinjection wells and associated operations that might lead to a reinjection well failure, and provide the opportunity to correct any occurrence of prohibited discharge activity. The person conducting the periodic inspection shall be acutely aware of the unlawful disposal of chemical compounds, petroleum products or other hazardous substances into the reinjection wells. If such activities are encountered, the permittee shall take immediate action to alleviate and correct such unlawful disposal.

(i) A periodic status report shall be conducted at least once every 90 days regarding the performance of the reinjection wells. The status report shall be made by a professional consultant, engineer, or geologist proficient in geothermal reinjection practices and geothermal energy production. The status report shall document the performance of the reinjection wells and shall follow the Department's guidelines for a reinjection well status report. The status reports shall be submitted to the Department for review after each report is completed.

2. Reporting of Noncompliance of Reinjection Limitations

The permittee shall notify the Department of any exceedance of the limitations specified in Part I A. 3., Reinjection Limitations, as determined by the monitoring and analyses specified in this permit. The notification shall consist of a report that shall include the monitoring and analytical results, and an explanation for the exceedance. The report shall be submitted to the Department within fifteen (15) days of knowledge of the exceedance.

3. Upset Condition

(a) In the event of an upset of facility operations that would require the discharge of geothermal injectate to a holding system, such as a lined surface impoundment, a daily record of the quantity being discharged into the holding system shall be maintained. Discharge quantity recordings shall be continuously made with the use of instruments that directly measure the flow of the effluent.

PERMIT ISSUED
Date APR 7 1993

(b) The Department shall be notified within 24 hours of any such discharge to a holding system.

(c) A summary report of the daily discharges to the holding system, resulting from each upset event, shall be submitted to the Department within 15 days after the cessation of the upset event.

(d) The Department shall be notified of the intent to discharge the contents of the holding system into the reinjection well. Discharge into the reinjection well shall only occur with the approval of the Department.

(e) Discharges of geothermal injectate to a holding system does not preclude the implementation of all sampling, analyses, and reporting conditions of this permit.

4. Additional Monitoring and Reporting

If the operation of the reinjection wells is additionally regulated by other pollution control programs, e.g., National Pollutant Discharge Elimination System (NPDES), the adherence to those monitoring and reporting requirements shall not be circumvented by the requirements and provisions of this permit.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained on site for a minimum of three (3) years from the date of the sample and shall be made available for inspection by the Director. This period may be extended by the request of the Director at any time.

6. Anticipated Changes

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may change any operating characteristics or conditions of the reinjection wells; or which may result in noncompliance with the permit conditions.

7. Notification of Change in Ownership or Control

In the event of any change in ownership or control of the reinjection wells, the owner shall report the change to the Director in writing at least one month prior to closing. Until such time as the permit is revoked and/or reissued, the permittee of record shall be responsible for the operation of the reinjection wells and for damages resulting from improper operation of the reinjection wells.

8. Twenty-Four Hour Reporting

The permittee shall report any deviation from the permit, including:

(a) Any monitoring, or other information, which indicates that any contaminant may cause an endangerment to a USDW.

(b) Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between USDWs.

(c) Any overflows of the reinjection well.

Such information shall be provided orally within 24 hours or the next business day of the Department from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five (5) days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance.

Oral reports shall be made to the Safe Drinking Water Branch at (808)586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258. In addition, for neighbor island occurrences, the Safe Drinking Water Branch Sanitarian shall be notified at (808)933-4552. The Director may waive the written report on a case-by-case basis if the oral report has been received immediately.

9. Definitions

(a) The "Department" means the Department of Health, State of Hawaii.

(b) The "Director" means the Director of Health or a duly authorized representative.

(c) "Facility or activity" means any UIC "reinjection well" or any other facility or activity that is subject to regulation under the UIC Program.

(d) "Fluid" means any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or any other form or state.

(e) "Reinjection well" means a "well" into which "fluids" are being emplaced or reinjected.

(f) "Reinjection pressure" means the head increase in the well bore with respect to static groundwater level.

(g) "USDW" means "underground source of drinking water" as defined in Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control.

PERMIT ISSUED
Date APR 7 1993

A. MANAGEMENT REQUIREMENTS:

1. Change in Discharge

All operations of the reinjection wells authorized herein shall be consistent with the terms and conditions of this permit. The operation of the reinjection wells identified in this permit at volumes in excess of that authorized shall constitute a violation of the permit conditions. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new UIC application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be revoked or modified to specify and limit any pollutants not previously limited.

2. Signatory Requirements

All reports or information submitted to the Director shall be signed and certified in accordance with Title 11, Chapter 23, Underground Injection Control, Section 12(b), Hawaii Administrative Rules.

3. Availability of Reports

All reports prepared in accordance with the terms of this permit shall be available for public inspection, with the approval of the Director, at the offices of the Director. Permit applications, permits, and well operation data shall not be considered confidential.

4. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to operate the reinjection wells. Proper operation and maintenance include, but are not limited to, effective performance, adequate funding, adequate operator staffing and training, adequate laboratory and process controls, including appropriate quality assurance procedures.

PERMIT ISSUED
Date APR 7 1993

5. Reapplication

If the permittee desires to continue an activity regulated by this permit after the expiration date of this permit, reapplication shall be made on the application forms then in use. This reapplication should be made not later than 180 days before this permit expires in order to facilitate processing of the renewal.

6. Abandonment Requirements

The owner who wishes to abandon the reinjection wells shall submit an application containing the details of the proposed abandonment. The Department will review the application and may require an abandoned well to be plugged in a manner which will not allow detrimental movement of fluids between formations. Abandonment procedures shall also comply with other applicable regulations of the Department of Land and Natural Resources.

B. GENERAL CONDITIONS

1. Operating Conditions

(a) No reinjection wells shall be operated, modified or otherwise utilized without a UIC permit issued by the Department.

(b) No person shall construct, operate, maintain, convert, plug, abandon or conduct any other reinjection activity in a manner which allows the movement of fluid containing a contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water rule or may otherwise adversely affect the health of one or more persons.

(c) The reinjection wells shall be operated in such a manner that does not violate any of Title 11, Hawaii Administrative Rules, regulating various aspects of water quality and pollution, and Chapter 342, HRS. The rules include:

(1) Chapter 11-20, "Potable Water Systems".
(2) Chapter 11-55, "Water Pollution Control".
(3) Chapter 11-62, "Wastewater Systems".

(d) If at any time the Department learns that a reinjection well may cause a violation of primary drinking water rules, the Department shall order the owner to take such actions as may be necessary to prevent the violation, including, where required, cessation of operation of the reinjection well.

PERMIT ISSUED
Date APR 7 1993

(e) Notwithstanding any other provision of this section, the Department shall issue a cease and desist order, effective immediately, upon receipt of information that a contaminant which is present in, or likely to enter, a system supplying water for human consumption, poses an imminent and substantial danger to the health of a person or persons.

2. Permit Issuance

A copy of this permit shall be retained by the facility and shall be made available for inspection by the Director.

This UIC permit shall not be transferable from the reinjection well owner to any other person.

This UIC permit shall be subject to revocation, suspension or revision by the Director if, after notice and opportunity for a contested hearing, it is determined that:

(a) There is a violation of any term or condition of the UIC permit; or

(b) The UIC permit was obtained by misrepresentation, or failure to fully disclose all relevant facts; or

(c) The UIC permit was willfully defaced, altered, forged or falsified; or

(d) There is a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted reinjection; or

(e) There is a failure to comply with these rules or any other applicable rules or laws.

All permit conditions will remain in effect despite the filing of a request by the permittee for a permit revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance.

3. Permit Modification

Any modification, alteration, or change to this permit shall be made only by written supplement or reissuance of the permit by the Department.

4. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

PERMIT ISSUED
Date APR 7 1993

5. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

6. The Director shall have the right to enter premises on which any reinjection well system is located; to inspect any equipment, operation, or sampling of any reinjection well system; to take effluent samples from any reinjection well system; and to have access to and copy any record required to be kept pursuant to this permit.

7. Need to Halt or Reduce an Activity not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

8. Penalties

It shall be a violation of Chapter 11-23 for any owner or operator of a reinjection well to construct, operate, maintain or close that well unless authorized by this chapter or by a permit or order to do so. It shall also be a violation of this chapter for any owner or operator to fail to comply with all of the applicable terms of the authorization, including those relating to inspection, monitoring, record keeping, and reporting. Compliance with a corrective order shall not excuse the basic violation. Any person who violates any provision of this chapter or this permit shall be subject to the penalties provided in section 340E-8, HRS or section 11-23-21, HAR.

9. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PERMIT ISSUED
Date APR 7 1993

A. OTHER REQUIREMENTS:

1. This permit shall be further subjected to the following provisions:

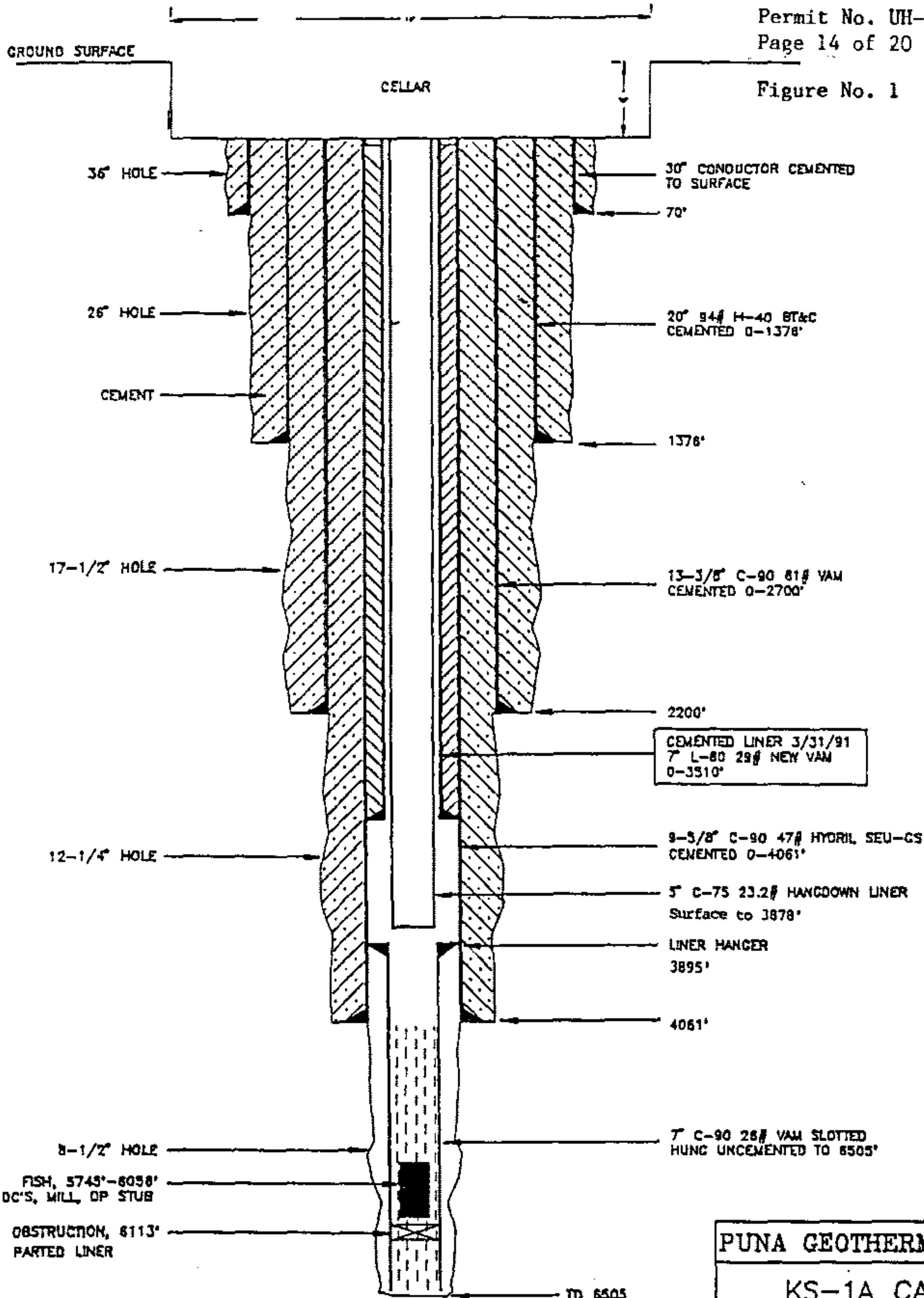
(a) The implementation of the "Hydrologic Monitoring Program" prepared by Science Applications International Corporation dated April 1990, or as modified with the written approval of the Department.

(b) The implementation of the "Production and Reinjection Well Casing Monitoring Program" prepared by Puna Geothermal Venture, completed in November 1991, or as modified with the written approval of the Department.

(c) This permit herein acknowledges that conditions affecting the Hydrologic Monitoring Program and the Production and Reinjection Well Casing Monitoring Program could warrant the reevaluation of the monitoring programs to address changing concerns. Modifications to the monitoring programs, resulting from reevaluations, shall be approved by the Department before implementation.

PERMIT ISSUED
Date APR 7 1993

Figure No. 1 (KS-1A)




| PUNA GEOTHERMAL VENTUR | | |
|---|---|---|
| KS-1A CASING SCHEMATIC AFTER REWOR AS OF 10/14/92 | | |
| BY W. TEPLOW | FILE: KS1ACAS.DWG | FIGURE NO. 1 |

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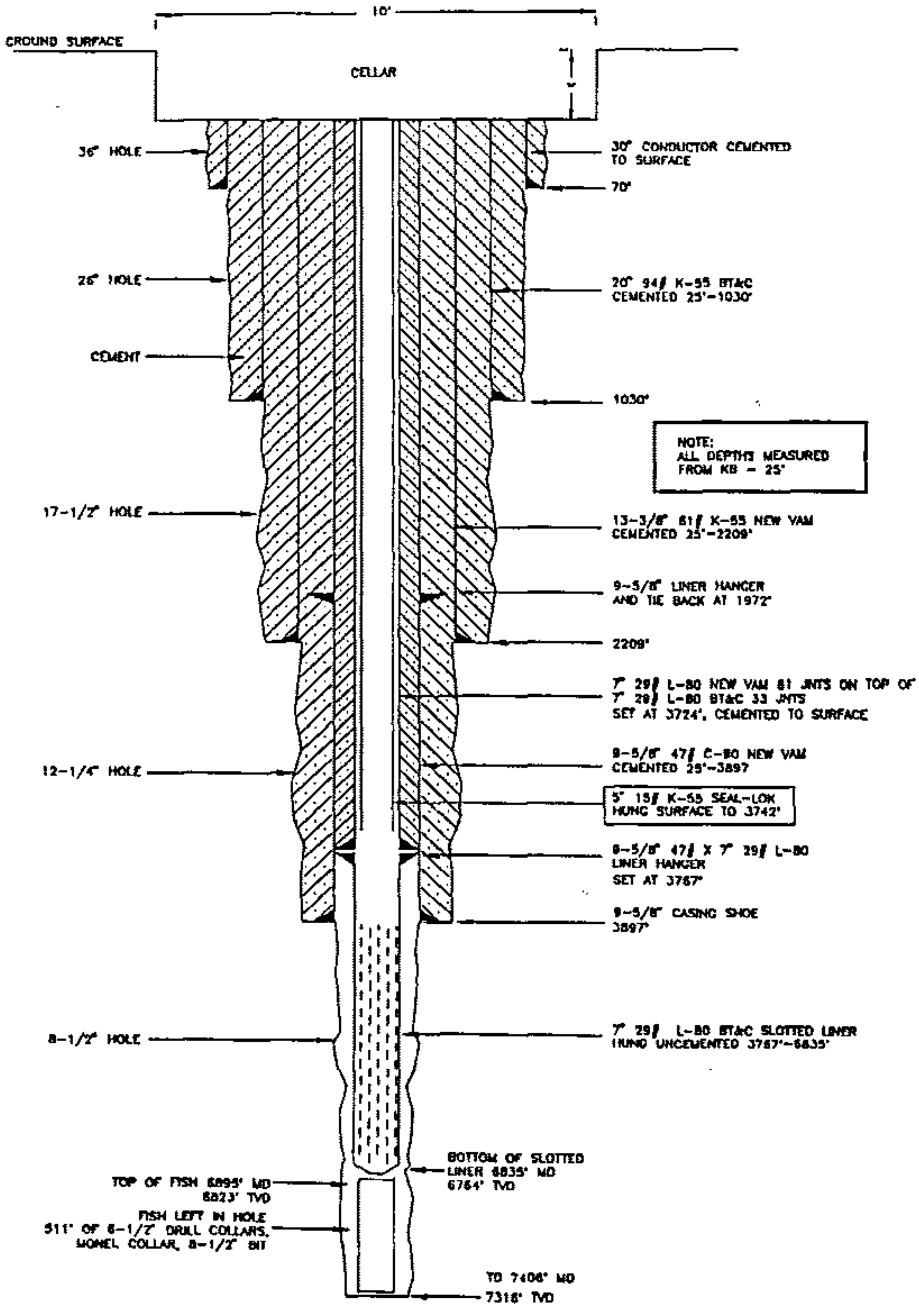
Date APR 7 1993




PUNA GEOTHERMAL VENTURE

KS-3 COMPLETION
SCHEMATIC AS OF
10/29/92

REV. 2

FIGURE NO. 2

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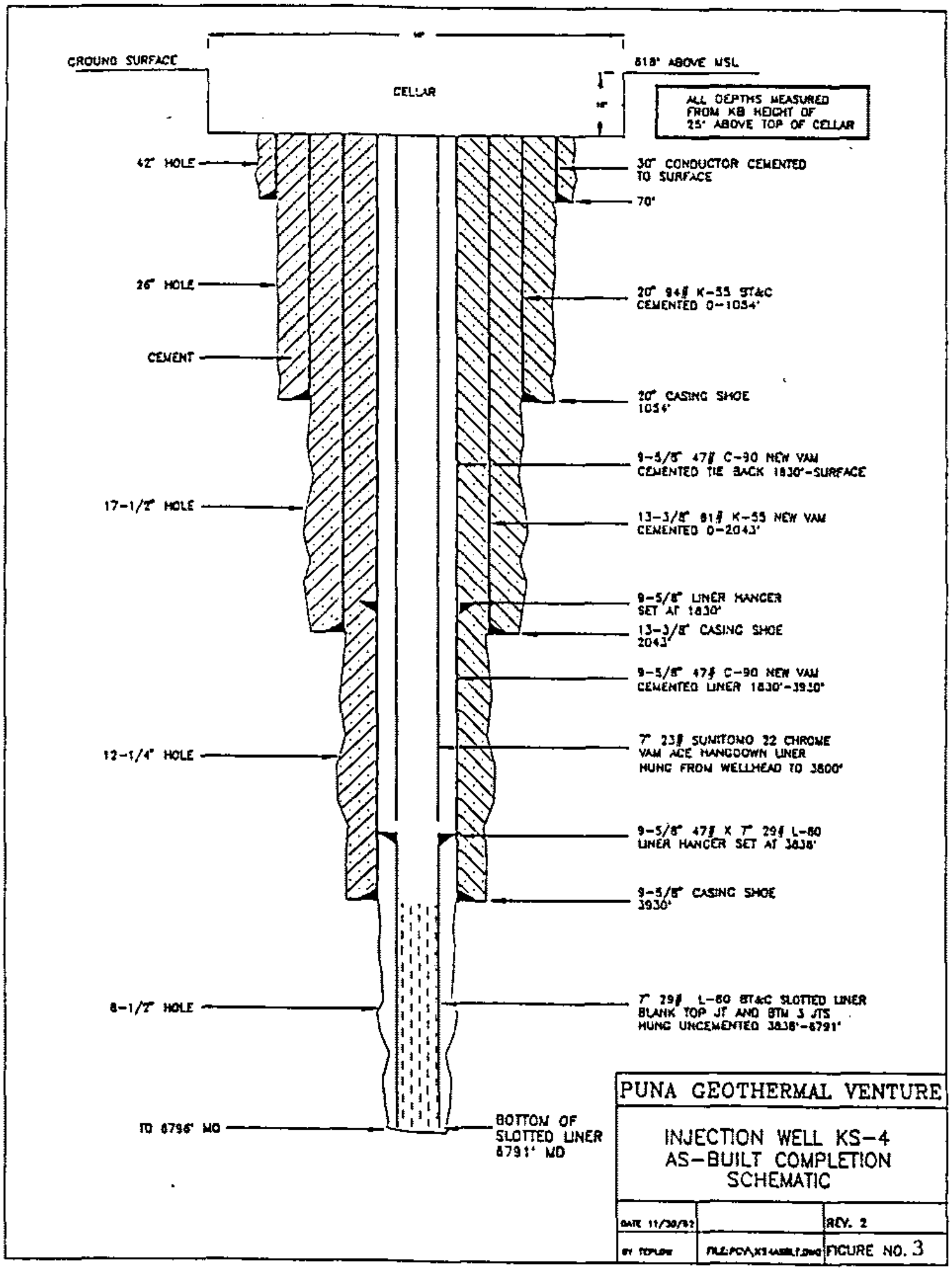
Figure No. 3 (KS-4)

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Date APR 7 1993

## TABLE NO. 1

### GEOTHERMAL LIQUID PARAMETERS

| | | | |
|---|---|---|---|
| Li | Lithium | S | Sulfur |
| Na | Sodium | Se | Selenium |
| K | Potassium | F | Fluorine |
| Mg | Magnesium | Cl | Chlorine |
| Ca | Calcium | Br | Bromine |
| Ba | Barium | I | Iodine |
| V | Vanadium | | |
| Cr | Chromium | $NH_3$ | Ammonia |
| Mn | Manganese | $SO_4$ | Sulfate |
| Fe | Iron | $NO_3$ | Nitrate |
| Ni | Nickel | $HCO_3$ | Bicarbonate |
| Cu | Copper | $CO_3$ | Carbonate |
| Ag | Silver | $SiO_2$ | (Silica) |
| Zn | Zinc | | |
| Cd | Cadmium | TDS | Total Dissolved Solids |
| Hg | Mercury | TSS | Total Suspended Solids |
| B | Boron | | Total Alkalinity |
| Pb | Lead | | Conductivity |
| As | Arsenic | | Density |
| | | | pH |
| | | | Oil & Grease |

### GEOTHERMAL NON-CONDENSIBLE GAS PARAMETERS

| | |
|---|---|
| $CO_2$ | Carbon Dioxide |
| $H_2S$ | Hydrogen Sulfide |
| $NH_3$ | Ammonia |
| Ar | Argon |
| $N_2$ | Nitrogen |
| $CH_4$ | Methane |
| He | Helium |
| $H_2$ | Hydrogen |

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TABLE NO. 2

CHEMICAL ADDITIONS FOR THE CONTROL OF CORROSION, SCALING AND PH

| Product Name | Chemical Ingredient |
|---|---|
| Amersite (R)2 | Sodium Bisulfite |
| Wrico Oxy 11 | Sodium Sulfite<br>Ethylenediamine Tetraacetic Acid<br>Sodium Salt |
| WPD 11-306 (Tm) | Dimethyldioctylammonium Chloride<br>Soya Amine Polyethoxylate<br>Cyclohexylamine |
| West R-322 | Polyamidoamino Acetate<br>POE (15) Tallow Amine |
| Midland 203 | Sodium Metabisulfite<br>Cobalt Compounds |
| Millsperse (R) 802 | Poly (Maleic Acid) |
| Sodium Hydroxide | Sodium Hydroxide (Na OH) |

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TABLE NO. 3

TYPE II SAMPLE CHEMICAL PARAMETERS

| Chemical Parameter | Regulatory Level (mg/l) | Method As described in 40 CFR (1992): |
|---|---|---|
| Ignitability | | Part 261.21 |
| Corrosivity | | Part 261.22 |
| Reactivity | | Part 261.23 |
| Inorganics: | | Method 1311 (TCLP), with appropriate methods of analyses contained in SW-846 |
| arsenic | 5.0 | |
| barium | 100.0 | |
| cadmium | 1.0 | |
| chromium | 5.0 | |
| lead | 5.0 | |
| mercury | 0.2 | |
| selenium | 1.0 | |
| silver | 5.0 | |
| Organics: | | 1311 |
| benzene | 0.5 | |
| carbon tetrachloride | 0.5 | |
| chlorobenzene | 100.0 | |
| chloroform | 6.0 | |
| o-cresol | 200.0 | |
| m-cresol | 200.0 | |
| p-cresol | 200.0 | |
| 1,4-dichlorobenzene | 7.5 | |
| 1,2-dichloroethane | 0.5 | |
| 1,1-dichloroethylene | 0.7 | |
| 2,4-dinitrotoluene | 0.13 | |
| hexachlorobenzene | 0.13 | |
| hexachloro-1,3-butadiene | 0.5 | |
| hexachloroethane | 3.0 | |
| methyl ethyl ketone | 200.0 | |
| nitrobenzene | 2.0 | |
| pyridine | 5.0 | |
| tetrachloroethylene | 0.7 | |
| trichloroethylene | 0.5 | |
| vinyl chloride | 0.2 | |

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TABLE NO. 4

TYPE III SAMPLE CHEMICAL PARAMETERS

| Chemical Parameter | Method |
|---|---|
| Volatile Organics: | 8240 (624) |
| Bromodichloromethane | |
| Bromoform | |
| Bromomethane | |
| Chloroethane | |
| 2-Chloroethylvinyl ether | |
| Chloromethane | |
| Dibromochloromethane | |
| 1,2-Dichlorobenzene | |
| 1,3-Dichlorobenzene | |
| 1,1-Dichloroethane | |
| trans-1,2-Dichloroethene | |
| 1-2-Dichloropropane | |
| cis-1,3-Dichloropropene | |
| trans-1,3-Dichloropropene | |
| Ethyl benzene | |
| Methylene chloride | |
| 1,1,2,2-Tetrachloroethane | |
| Toulene | |
| 1,1,1-Trichloroethane | |
| 1,1,2-Trichloroethane | |
| Trichlorofluoromethane | |

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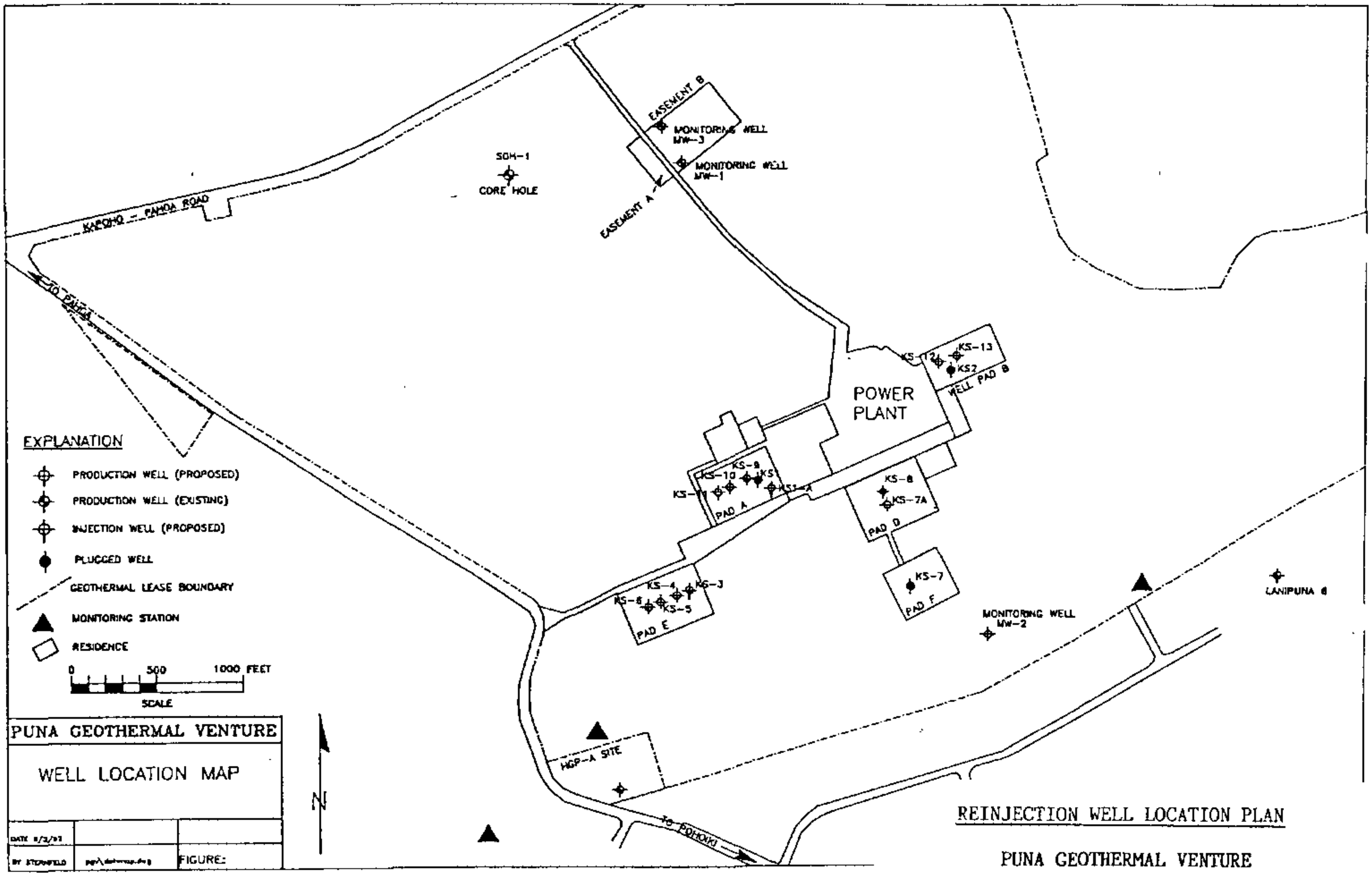
Date APR 7 1993




REINJECTION WELL LOCATION PLAN

PUNA GEOTHERMAL VENTURE

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii

UIC Permit No. UH-1529

JOHN W. IHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIKE

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

REF:WL-LC

JAN 29 1993

Mr. Steven Morris
Vice President
Puna Geothermal Venture
P.O. Box 30
Pahoa, Hawaii 96778

Dear Mr. Morris:

Injection Wells KS-1A and KS-3

Attached is the Department of Health's Underground Injection Control Permit No. UH-1529 for re-injection of geothermal fluids into KS-1A and KS-3. With the issuance of this permit, the Department of Land and Natural Resources' Geothermal Well Modification and Conversion permit requirements have been satisfied and you may therefore commence injection operations for KS-1A and KS-3.

Should you have any questions regarding the permit requirements for KS-1A and KS-3, please contact Mr. Manabu Tagomori of the Division of Water and Land Development at 587-0230.

Very truly yours,

WILLIAM W. PATY

Enc.

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

JOHN P. KEPPELER, II
DONA L. HANAIKE

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WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P.O. BOX 621
HONOLULU, HAWAII 96809

REF:WL-LC

JAN 20 1993

Mr. Steven Morris
Vice President
Puna Geothermal Venture
745 Fort Street Mall
Honolulu, Hawaii 96813

Dear Mr. Morris:

<u>KS-1A Five-Inch Hangdown Liner Modification</u>

Your KS-1A modification plan to install a 5-inch hangdown liner with pressurized nitrogen in the annulus to detect leaks in the 7-inch casing, submitted by Mr. Tom Kizis' October 5, 1992 letter, is approved.

Please note that the conditions of our February 13, 1992 Drilling Permit for KS-1A are still applicable for the installation of this 5-inch liner.

Should you have any questions, please contact Mr. Manabu Tagomori of the Division of Water and Land Development at 587-0230.

Very truly yours,

John P. Keppeler II
for WILLIAM W. PATY

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED
92 NOV 20 A 9:15
DEPT. OF LAND & NATURAL RESOURCES
STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

RECEIVED
'92 NOV 24 A 9:42
DIV. OF WATER & LAND DEVELOPMENT

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EMD / SDWB

November 10, 1992

To: Underground Injection Control Permittees and Interested Parties

From: Bruce S. Anderson, Ph.D.
Deputy Director for Environmental Health

Subject: HAWAII ADMINISTRATIVE RULES
TITLE 11, CHAPTER 23, UNDERGROUND INJECTION CONTROL
DOCKET NO. 91-SDW-REG-2

The proposed revisions to the subject rules were signed by Governor John Waihee and became effective on November 12, 1992. Enclosed is a copy of the final rules.

The final approved rules are essentially the same as the information which was provided during the public comment period. Only minor changes were made as a result of the comments received during the public comment period. These changes can be summarized as follows:

1. Section 11-23-05(d) Identification of exempted aquifers and USDW.

The public hearing version read:

> Special geothermal exempted aquifers shall be identified as any area which has been designated as a geothermal resource subzone, in accordance with sections 205-5.1 and 205-5.2, HRS and chapter 13-184, Hawaii Administrative Rules.

This proposed exempted aquifer was deleted from the final rules. It was pointed out by many commenters, including the United States Environmental Protection Agency, that all exempted aquifers must meet the criteria established in section 11-23-04. Since the geothermal resource subzone designation does not necessarily imply compliance with section 11-23-04, it would be improper to automatically exempt such aquifers.

3. Sections 11-23-06(b)(3) Classification of injection wells and 11-23-07(b) Prohibition.

   The public hearing version used the term:

   "non-exempted aquifer(s)"
   The final rules have replaced this with the more straightforward, equivalent term:

   "underground source(s) of drinking water"

   The Department of Health concurred with the comments made by the United States Environmental Protection Agency, that the term, non-exempt aquifers, was unnecessarily awkward and confusing. Please note that section 11-23-05(c) clearly states that,

   "Unless expressly exempted, all aquifers are considered to be USDW."

Thank you for your interest in the protection of public health and the environment. If you should have any questions please contact the Underground Injection Control program at 586-4258.

Enclosure

DEPARTMENT OF HEALTH

Amendment and Compilation of Chapter 11-23

Hawaii Administrative Rules

September 28, 1992

Summary

1. §11-23-01 to 11-23-14 are amended.

2. §11-23-16 to 11-23-17 are amended.

3. A new §11-23-21 is added.

4. §11-23-22 is amended and renumbered.

5. §11-23-23 is renumbered.

HAWAII ADMINISTRATIVE RULES

TITLE 11

DEPARTMENT OF HEALTH

CHAPTER 23

UNDERGROUND INJECTION CONTROL







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"Grouting" means the operation whereby a cement slurry is forced behind the casing for such purposes as: sealing the casing to the walls of the hole, preventing undesirable leakage of fluids out of the hole, and preventing migration of liquids or gases into the hole; or is pumped into a drill hole or well for plugging and abandonment.

"Hazardous waste" means a hazardous waste as defined extensively in Code of Federal Regulations (CFR), Title 40-Protection of Environment, section 261.3 dated July 1, 1990.

"HRS" means Hawaii Revised Statutes.

"Individual wastewater system (IWS)" means the facility which disposes of treated or untreated domestic wastewater generated from a room or group of rooms forming a single habitable unit, including, but not limited to, cesspools, septic tanks and household aerobic units.

"Industrial" means associated with a productive enterprise using machinery and mechanical power or human power or both, including such enterprises as power generation and crop production.

"Inject" means to dispose or emplace fluids, either under pressure or by gravity flow, into a subsurface formation or formations.

"Injection pressure" means the head increase in the well bore with respect to the static ground water level; where head refers to the total energy of the fluid at any given point; and in ground water the main components of head are elevation and pressure.

"Injection well" means a well into which subsurface disposal of fluid or fluids occurs or is intended to occur by means of injection.

"Makai" means toward the sea or the area outside the UIC line encircling the protected aquifer.

"Mauka" means toward the mountains or the encircled protected aquifer.

"Modify" means to make a minor or a basic change in the physical characteristics or the operational status of a well.

"Person" means any individual, partnership, firm, association, public or private corporation, trust estate, the federal, state or county governments or any of their agencies, or any other legal entity.

"Pollute" means:

(1) To alter the physical, chemical, biological or radiological properties of any state waters or USDW, including but not limited to temperature, taste, potability, mineral content, turbidity, color or odor; or







(2) To discharge any liquid, gaseous, solid, radioactive, or other substances, into any state waters as will or is likely to create a nuisance or render such waters harmful, detrimental or injurious to public health, safety or welfare, including harm, detriment, or injury to public or private drinking water supplies.

"Sewage" means waste from all plumbing fixtures in residences, institutions, public and private buildings, and other places of human habitation, employment or recreation, whether treated or not by public or private sewage treatment plants.

"State" means State of Hawaii.

"UIC" means the underground injection control program under Part C of the Safe Drinking Water Act (P.L. 93-523) and chapter 340E, HRS.

"UIC line" or "the line" means the line on the department of health UIC maps which separates, in plan view, exempted aquifers and USDW.

"Underground source of drinking water (USDW)" means an aquifer or its portion:

(1) Which supplies any public or private drinking water system; or contains a sufficient quantity of ground water to supply a public water system; and
   (A) Currently supplies drinking water for human consumption; or
   (B) Contains fewer than ten thousand milligrams per liter (mg/L) total dissolved solids (TDS); and

(2) Which is not an exempted aquifer.

"Volcanic" means material originating from a volcano; often, basaltic lava.

"Waste" means any solid, liquid or gaseous matter, whether treated or not, which, when injected, may pollute or tend to pollute the lands or waters, including, but not limited to, sewage; effluent; offal; garbage; refuse; and industrial, agricultural or radioactive fluids.

"Waste disposal system" means an excavation in the ground receiving wastes which functions by allowing fluids to seep through its bottom, sides or both, including cesspools, septic tanks, and seepage pits.

"Well" means a bored, drilled or driven shaft, or a dug hole, whose depth is greater than its widest surface dimension.

The publications referred to or incorporated by reference in this chapter are available from the offices of the department of health. [Eff. 7/6/84; am and comp NOV 12 1992 ] (Auth: HRS §340E-2) (Imp: HRS §340E-2, 40 CFR §§144.3 and 146.3)



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(3) Class III. Wells which inject for extraction of minerals including:
(A) Mining of sulfur by the Frasch process;
(B) In-situ production of uranium or other metals, using unconventional techniques to mine ore bodies; and
(C) Solution mining of salts or potash.

(4) Class IV. Wells used by generators of hazardous waste or of radioactive waste, by owners or operators of hazardous waste management facilities, or by owners or operators of radioactive waste disposal sites to dispose of hazardous waste or radioactive waste into any geohydrologic formation or a formation, which, within one-quarter of a mile of the well, contains an underground source of drinking water (USDW), even if exempted.

(b) Without exception, only class V wells shall be permissible and are defined as follows:

(1) Subclass A. Injection wells which inject fluids into an underground source of drinking water. Subclass A wells include:
(A) Sewage injection wells; and
(B) Industrial disposal wells other than those classified under subclasses AB or B.

(2) Subclass AB. Injection wells which inject only into exempted aquifers. Subclass AB wells include:
(A) Sewage injection wells; and
(B) Industrial disposal wells, other than those classified under subclass B, such as brine disposal wells used in a desalinization process.

(3) Subclass B. Injection wells which inject non-polluting fluids into any geohydrologic formation, including underground sources of drinking water. Subclass B wells include:
(A) Air conditioning return flow wells used to return the water used for heating or cooling in a heat pump;
(B) Cooling water return flow wells used to inject water previously used for cooling;
(C) Recharge wells used to replenish, augment, or store water in an aquifer;
(D) Salt water intrusion barrier wells, used to prevent the intrusion of salt water into fresh water, if they inject water of equal or lesser chloride concentration as that portion of the aquifer into which injected;







(E) Wells used in aquaculture, if the water in the receiving formation has, either:
(i) An equal or greater chloride concentration as that of the injected fluid; or
(ii) A total dissolved solids concentration in excess of five thousand mg/L.
(F) Injection wells used in an experimental technology, which is one that has not been proven feasible under the conditions in which it is being tested; and
(G) All wells not included in subclasses A, AB, C, D, or E of class V or in classes I through IV.

(4) Subclass C. Injection wells which inject surface fluids, i.e., storm runoff, into any geohydrologic formation.

(5) Subclass D. Injection wells which inject overflows, or relief flows, from potable water systems into any geohydrologic formation.

(6) Subclass E.

(A) Injection wells associated with the development and recovery of geothermal energy, provided that the geothermal effluent will be injected at a depth that will not be detrimental to underground sources of drinking water. If injection is to occur below the basal water table, the receiving formation water shall be tested and injection allowed if the receiving water has, either:
(i) An equal or greater chloride concentration as that of the injected fluid; or
(ii) A total dissolved solids concentration in excess of five thousand mg/l; or
(iii) An equivalent or lesser water quality than the injected fluid.

(B) Subclass E injection wells include:
(i) Brine injection wells for the disposal of excess water from the steam-flashing process;
(ii) Condensate injection wells for the disposal of condensate from electric generators; and
(iii) Gas injection wells for the disposal of non-condensible gases entrained in an aqueous solution. [Eff. 7/6/84; am and comp NOV 12 1992 ] (Auth: HRS §340E-2) (Imp: HRS §340E-2, 40 CFR §§144.6 and 146.5)

(e) Vertical migration resulting in undesirable mixing of fluids from aquifers of substantially different water quality (due to improper well construction or use of an injection well) shall be prevented by preserving the integrity of the confining zone or zones by grouting or some other method acceptable to the department.

(f) If a large void, such as a lava tube or solution cavity, is encountered during drilling, where the drill rod drops more than three feet, measures shall be taken to prevent unacceptable migration of the injected fluids. The owner shall either verify that the void does not slope inland or construct the well in such a manner that wastes are not injected directly into the void. For the first option, a test boring which verifies the void's inclination inland of the wellsite shall be drilled. For the second option, the section of the well casing which passes through the void shall be without openings. Either the perforated casing shall be replaced with solid casing, or the holes in the casing shall be sealed by grouting or in some other manner approved by the department. The owner shall notify the department to arrange discussion and approval of any corrective actions. Scheduling of the procedures shall be arranged so that the departmental staff may observe the remedial operations. The final responsibility for remedial design, implementation and performance shall rest with the consulting engineer.

(g) Departmental staff shall have the right to enter property during normal working hours, without advance notification, for the purpose of observing injection well construction methods and progress. [Eff. 7/6/84; am and comp NOV 12 1992 ] (Auth: HRS §340E-2) (Imp: HRS §§340E-2 and 340E-9, 40 CFR §§144.12, 144.51 and 146.6)

§11-23-10 <u>Provision for artesian aquifer protection.</u> (a) Where an injection well is located in a caprock formation which overlies volcanic USDW under artesian pressure, the following conditions shall be applied:

(1) A buffer zone of at least fifty feet of the confining materials (caprock) or other impermeable substance, shall remain between the bottom of the injection well and the top of the volcanic aquifer, and

(2) Injection pressure, as measured at the feed elevation or well head, shall remain below the hydrostatic pressure of the volcanic aquifer (the artesian head) or two p.s.i., whichever is greater.

(b) The locations of artesian aquifer areas are described generally. The major areas, which have an extensive caprock formation, include:







(1) The southern coastal plains of Oahu, from Kahe Pt. (West Beach) to Wailea Pt. (Lanikai);

(2) The windward (eastern) coastal plains of Oahu, from Makalii Pt. (Punaluu) to Waialee;

(3) The northern coastal plains of Oahu, from Haleiwa to Mokuleia; and

(4) The Mana Plain on western Kauai, from Polihale to Kekaha.

Other artesian aquifer areas are found in valleys, where alluvium or other sedimentary material has been deposited to significant depths.

(c) If the ratio of the depth of the proposed injection well, to the estimated depth of caprock less fifty feet, is 1:2 or less, the applicant need not extend the depth of the injection well or wells in order to verify caprock thickness, prior to completion at the shallower proposed depth. The department shall estimate the depth of caprock by comparing lithology from logs of borings in the vicinity. If, however, artesian aquifer conditions are encountered, the applicant shall have the options as set forth in subsection (f). The following is a table showing the depths needed to achieve the 1:2 ratio:

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Proposed depth of injection well: | 10 | 15 | 20 | 25 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| Minimum depth of caprock: | 70 | 80 | 90 | 100 | 110 | 130 | 150 | 170 | 190 | 210 | 230 | 250 |

(d) If the ratio of the depth of the proposed injection well, to the estimated depth of caprock less fifty feet, is greater than 1:2, the applicant shall have the depth of the injection well temporarily extended by fifty feet to verify that artesian aquifer conditions are not encountered within that range. The fifty feet of extended hole shall be properly sealed by the tremie method, with a cement slurry that contains no more than five gallons of water per ninety-four pound sack of cement.

(e) Where a test well is planned for either a single injection well or a multiple well field, the depth of the test well shall be extended fifty feet into confining materials beyond the proposed depth of the deepest well. If the test well is intended to be operational, the lower fifty feet shall be properly sealed as detailed in subsection (d) of this section.

(f) Where artesian aquifer conditions are unexpectedly encountered, the applicant may choose to:

(1) Abandon and properly seal the injection well with neat cement and request approval for a new location; or



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(f) All applications for the use of subclass C wells to inject storm runoff shall be reviewed by the department for the determination of whether or not an applicant shall be required to obtain a UIC permit to operate the wells. The determination for an exemption of a UIC permit for such wells shall be made by the director and shall be predicated on the conditions submitted in the UIC application. If an exemption is granted, the operating conditions as submitted in the application shall remain unchanged for the subclass C wells. If any of the operating conditions should change over time, a new application shall be submitted by the owner of the wells for review by the department for the purpose of determining the need for a UIC permit. The determination for a permit exemption shall be based on, but not limited to:

(1) The location and design of the injection wells;
(2) The surrounding land areas contributing runoff to the injection wells;
(3) The potential for the inclusion of contaminants in the runoff;
(4) The impact on underground sources of drinking water; and
(5) The comments received during the public notice period or public hearing, or both, for proposed subclass C wells injecting into underground sources of drinking water. [Eff. 7/6/84; am and comp NOV 12 1992] (Auth: HRS §340E-2) (Imp: HRS §340E-2, 40 CFR §§144.24 and 144.33)

§11-23-13 <u>Submission of data.</u> (a) Each applicant shall provide the following:

(1) Facility name and description;
(2) Facility location, including street address and zip code;
(3) Tax map key (TMK) number and map at the most detailed scale available, showing the location of the proposed injection well or wells on the property, the correct scale and north arrow;
(4) USGS topographic quadrangle map or good copy (scale 1:24,000) indicating the location of the proposed injection well or wells, and all other injection and withdrawal wells within one-quarter mile of the facility boundary;
(5) Ownership of facility;
(6) Name and address of lessor, if applicant is a lessee, and written consent of the property owner;
(7) Name and address of legal contact;







(8) Name of proposed operator;
(9) Nature and source of injected fluid;
(10) Proposed design capacity and operating volume of injected fluid;
(11) Number and type of injection wells, including construction materials and procedures;
(12) Elevation section for proposed well or wells, as found on the application form;
(13) Description of injection system, including emergency standby or monitoring wells, if any, and system blueprints;
(14) Details of proposed injection testing, the duration of which shall be for not less than twelve hours, and preferably for twenty-four hours;
(15) For injection wells sited mauka of the UIC line, water quality data, including, at a minimum, values for chloride, total dissolved solids, and coliform, from several of the nearest water supply wells;
(16) Number of each type of injection well actually constructed, including emergency standby and monitoring wells, if any;
(17) Well log maintained by a geologist, including:
    (A) Lithology of injection interval or intervals and confining formation or formations;
    (B) Physical and structural characteristics of the formations encountered;
    (C) Initial water level, and subsequent water levels as fluctuations occur, especially for artesian conditions; and
    (D) Tidal fluctuations and efficiency;
(18) Elevation section, as found on the application form, showing exact final dimensions for each of the injection wells and materials used in construction;
(19) Complete results of injection testing, including maximum capacity;
(20) Water quality data, if required;
(21) Nature and source of formation water;
(22) Description of operating plans, including identification of legal operator, maximum and average volumes of injected fluids, number of hours per day of use, and degree and type of treatment, if any.

(b) A hearing may be held if the director determines that there is significant public interest. Any hearing brought pursuant to this section shall be held in the geographical area of the proposed injection or other appropriate area, at the discretion of the director, and may, as appropriate with respect to geographic area, consider more than one UIC permit application.

(c) The public shall be given public notice of any hearing held pursuant to this section. The notice for the hearing shall include at least the following:

(1) Notice shall be published at least once in a newspaper of general circulation within the geographical area of the injection site;
(2) Notice shall be sent to all persons who received a copy of the notice for the UIC permit application;
(3) Notice shall be mailed to any person or group upon request; and
(4) Notice shall be issued at least thirty days in advance of the hearing.

(d) The public notice of any hearing held pursuant to this section shall include at least the following information:

(1) Name, address and phone number of agency holding the public hearing;
(2) Name and address of each UIC applicant whose application will be considered at the hearing;
(3) Name of USDW area where injection is proposed and a short description of the underground source of drinking water aquifer;
(4) A brief reference to the public notice issued for each UIC application being considered, including identification number and date of issuance;
(5) Information regarding the time and location of the hearing;
(6) The purpose of the hearing;
(7) A concise statement of the issues raised by the persons requesting the hearing;
(8) Address and phone number of the state agency premises at which interested persons may obtain further information, and inspect and copy UIC forms and related documents; and
(9) A brief description of the nature of the hearing, including the rules and procedures to be followed. [Eff. 7/6/84; comp NOV 12 1992 ] (Auth: HRS §340E-2) (Imp: HRS §340E-2, 40 CFR §145.31)







§11-23-16 Permit issuance. (a) The director shall issue a UIC permit for wells which propose to inject into exempted aquifers on the following basis:

(1) Existing or new injection wells do not or will not endanger the quality of underground sources of drinking water.
(2) Existing or new injection wells are designed and are or will be constructed or modified to operate without causing a violation of these rules or other applicable laws.
(3) Proposed injection wells are designed and built in compliance with the standards and limitations stated in sections 11-23-07 to 11-23-10.

(b) The issuance of a UIC permit for wells which propose to inject into USDW shall be based, in addition to subsection (a)(1) to (a)(3) of this section, upon the evaluation of the contamination potential of the local water quality by the injection fluids and the water development potential for public or private consumption. The public shall have an opportunity to present information about these aspects of the proposed project.

(c) The director may issue a UIC permit for any period of time, not to exceed five years.

(d) The director shall review applications for reissuance of UIC permits. Applications for reissuance must be filed at least 180 days prior to UIC permit expiration. UIC permits may be reissued based upon the submission and review of data, as outlined in section 11-23-13, as deemed appropriate by the director at that time.

(e) The UIC permit shall not be transferable from the injection well owner to any other person without the approval of the director. Request for transfer from one person to another shall be made on an application form furnished by the director along with any other data deemed appropriate. [Eff. 7/6/84; am and comp NOV 12 1992 ] (Auth: HRS §340E-2) (Imp: HRS §§340E-2, and 340E-9, 40 CFR §§144.11, 144.12, 144.36, 144.38, 144.39 and 144.41)

§11-23-17 Existing injection well registration. (a) The application procedures for a UIC permit, as stated in section 11-23-12, shall apply to owners of existing injection well facilities.

(b) By August 6, 1984, the owner of any existing injection well or wells shall notify the department of the existence of the well, whether or not in use, and shall provide the department with the information required by section 11-23-13(a)(1) through (a)(7).

(b) In taking any action the director may consider operating records, compliance investigations, or other information regarding the injection well facility or impact on the USDW aquifer. [Eff. 7/6/84; comp NOV 12 1992 ] (Auth: HRS 340E-2) (Imp: HRS 340E-2, 40 CFR §145.31)

§11-23-21 Inspection and entry. The director shall have the right:

(1) To enter premises on which any injection well system is located;
(2) To inspect any equipment, operation, or sampling of any injection well system;
(3) To take effluent samples from any injection well system; and
(4) To have access to and copy any record required to be kept pursuant to this chapter. [Eff. and comp NOV 12 1992 ] (Auth: HRS 340E-2, 340E-9) (Imp. HRS 340E-2, 340E-9; 40 CFR 144.51)

§11-23-22 Penalties. Any person who violates any provision of this chapter shall be subject to the penalties provided in section 340E-8, HRS. Compliance with a corrective order shall not excuse the basic violation. [Eff. 7/6/84; am, comp and ren §11-23-21 NOV 12 1992 ] (Auth: HRS §340E-7) (Imp: HRS §340E-8, 40 CFR §§144.11 and 145.13)

§11-23-23 Severability. If any provision of this chapter or its application to any person or circumstances is held invalid, the application of such provision to other persons or circumstances, and the remainder of this chapter, shall not be affected thereby." [Eff. 7/6/84; comp and ren §11-23-22 NOV 12 1992 ] (Auth: HRS §340E-9) (Imp: HRS §340E-9)



The amendments to and compilation of Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control, on the Summary Page dated SEP 28 1992, were adopted on SEP 28 1992, following a public hearing conducted on June 13, 1991 by means of a tele-video conference communication held on Oahu with simultaneous transmission to Hilo, Hawaii and Lihue, Kauai, after the public notice was printed in the Honolulu Advertiser, Hawaii Tribune-Herald, West Hawaii Today, Maui News, and Kauai Times, on April 24, 1991.

These rules shall take effect ten days after filing with the Office of the Lieutenant Governor.

JOHN C. LEWIN, M.D.
Director of Health

Dated: SEP 28 1992

APPROVED:

JOHN WAIHEE
Governor
State of Hawaii

Dated: NOV 02 1992

APPROVED AS TO FORM:

Lawrence K. Lau
Deputy Attorney General

Filed



1582

JOHN WAIHEE
GOVERNOR OF HAWAII

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

92 OCT 21 P3:33

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:
EMD / SDWB

October 21, 1992

To: The Honorable William W. Paty, Chairperson
Department of Land and Natural Resources

From: John C. Lewin, M.D. [signature] for
Director of Health

Subject: UNDERGROUND INJECTION CONTROL (UIC) PERMIT
FOR PUNA GEOTHERMAL VENTURE
UIC PERMIT NO. UH-1529

We are transmitting the Department's underground injection control permit for Puna Geothermal Venture. This transmittal is pursuant to the agreement between the Department of Health and the Department of Land and Natural Resources relating to the construction of geothermal production and reinjection wells. Please transmit this permit to Puna Geothermal Venture to be kept in their possession for the duration of the permit.

JOHN WAIHEE
GOVERNOR OF HAWAII

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

In reply, please refer to:
EMD / SDWB

October 21, 1992

Mr. Steven E. Morris
Vice President and General Manager
Puna Geothermal Venture
P. O. Box 30
Pahoa, Hawaii 96778

Dear Mr. Morris:

SUBJECT: PUNA GEOTHERMAL VENTURE
UNDERGROUND INJECTION CONTROL (UIC)
UIC APPLICATION NO. UH-1529

The Department of Health has completed its review of your UIC application. It has been determined that the conditions required for the granting of approval to operate two (2) reinjection wells at the subject facility have been satisfied. Therefore, you are hereby granted approval to operate the two (2) reinjection wells under the terms and conditions of the enclosed permit.

Your facility and reinjection wells have been assigned the following identification numbers:

**UIC Permit No. UH-1529**
**Facility ID No. 8-2883.01**
**Well No. KS-1A and KS-3**

Please refer to these identification numbers, along with your UIC permit number, in all future correspondence with this office.

A guidelines document for a reinjection well status report has been enclosed for your reference. The guidelines document shall be used as referenced in the UIC permit under "Monitoring And Reporting Requirements."

Failure to comply with the terms and conditions of the permit will constitute a violation of the permit. Any person who violates the permit requirements or any provision of Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control, shall be subject to the penalties provided in Section 340E-8, Hawaii Revised Statutes.

Failure to comply with the terms and conditions of the permit will constitute a violation of the permit. Any person who violates the permit requirements or any provision of Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control, shall be subject to the penalties provided in Section 340E-8, Hawaii Revised Statutes.

If you have any questions regarding your permit, or the UIC Program, please contact Chauncey Hew of the Safe Drinking Water Branch at 586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258.

Sincerely,

Thomas E. Arizumi

THOMAS E. ARIZUMI, P.E., Chief
Environmental Management Division

CH:kt

Enclosures: 1. UIC Permit
2. Reinjection Well Status Report Guidelines

c:
1. Glenn Tomori, SDWB Sanitarian, Hilo (w/encl. of Permit)
2. Norman Hayashi, Planning Department, County of Hawaii (w/encl. of Permit)
3. William Paty, DLNR (w/encl. of Permit)
4. Mufi Hannemann,DBEDT (w/encl. of Permit)
5. Clarence Tenley, EPA (w/encl. of Permit)

Permit No. UH-1529

AUTHORIZATION TO OPERATE UNDER THE
UNDERGROUND INJECTION CONTROL PROGRAM

In compliance with the provisions of the Safe Drinking Water Act, Chapter 340E, Hawaii Revised Statutes (HRS), as amended, and Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control;

PUNA GEOTHERMAL VENTURE

is authorized to operate a Class V, Subclass B, geothermal reinjection well system consisting of two (2) reinjection wells; known as geothermal wells Kapoho State 1A (KS-1A) and Kapoho State 3 (KS-3):

| Reinjection Well No. | Operational Status | Located on Well Pad | Approx. Well Head Elevation Above Mean Sea Level |
|---|---|---|---|
| KS-1A | Primary Injector | A | 617 feet |
| KS-3 | Standby Injector | E | 618 feet |

and having the specifications as listed in Figure No. 1 and Figure No. 2, respectively; to reinject the geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal noncondensible gases which are produced during the operation of the well field and power plant; and the intermittent inclusion of reinjection supplement water; back into the geothermal reservoir at an interval between the approximate depths of 3,900 feet and 7,300 feet;

located at the facility's address of 14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778; at Tax Key Number, 3rd Div. 1-4-01:2 and 19; at the approximate well pad coordinates:

Well Pad A: Latitude 19° 28′ 49″ N and Longitude 154° 53′ 35″ W;
Well Pad E: Latitude 19° 28′ 41″ N and Longitude 154° 53′ 40″ W;

in accordance with monitoring requirements and other conditions set forth in Parts I, II and III hereof.

This permit will become effective upon issuance.

This permit and the authorization to operate the reinjection wells will expire at midnight, October 20, 1995.

Issued on the 21st day of October 1992.

PERMIT ISSUED
Date OCT 21 1992

(For) Director of Health

A. THE OPERATION OF THE REINJECTION WELLS SHALL BE LIMITED TO:

1. Operational Status

(a) Reinjection Well KS-1A shall be used as the primary reinjection well to service the operations of the power plant.

(b) Reinjection Well KS-3 shall be used only as a standby reinjection well. The use of KS-3 shall only occur during a shutdown of the production well as a result of any dysfunction in the primary reinjection well. The maximum duration of time for the use of KS-3 shall be 24 hours, or the duration of time that is required to shutdown the production well, whichever is less.

2. Injectate Characteristics

The reinjection of geothermal fluids consisting of geothermal brine, geothermal steam condensate, geothermal noncondensible gases, chemical additions for well casing corrosion and scale control, and reinjection supplement water, that may include the chemical parameters as listed in Table No. 1 as being representative of the geothermal fluid.

3. Reinjection Limitations

(a) Reinjection Pressure:

The reinjection pressure as measured at the well head shall not exceed 500 psi gauge or the fracture pressure of the receiving formation, whichever is less.

(b) Reinjection Quantity and Rate:

The reinjection quantity and rate shall be commensurate with the production of up to twenty-five (25) megawatts, net power.

The reinjection rate shall be limited to a total of approximately 675,000 lbs./hr., or to a rate commensurate with the reinjection capacity of the reinjection wells, whichever is less. The approximate composition of the injectate based on 675,000 lbs./hr. is:

| | |
|---|---|
| Steam Condensate | 505,816 lbs./hr. |
| Brine | 128,250 lbs./hr. |
| Supplement Water and/or Brine from the Storage Pits | 39,751 lbs./hr. |
| Total Noncondensible Gases | 1,183 lbs./hr. |
| Total | 675,000 lbs./hr. |

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(c) Concentrations of the Injectate:

The concentrations of the chemical parameters of the geothermal fluid listed in Table No. 1 are recognized as being variable and peculiar to the geothermal resource and the processes of geothermal energy production. Therefore, concentrations as such, for the purpose of setting maximum chemical levels, are not listed in this permit; however, chemical analyses are required as detailed in Part I, Section B of this permit.

(d) Chemical Additions:

To maintain the integrity and function of well casings, the use of chemical additions to the reinjection wells and production wells are hereby acknowledged and listed. The chemical ingredients of the products are listed in Table No. 2.

| Product Name | Function | Location of Use |
|---|---|---|
| Amersite (R) 2 | Corrosion Inhibitor | Reinjection Well |
| Wrico Oxy 11 | Corrosion Inhibitor | Reinjection Well |
| WPD 11-306 (Tm) | Corrosion Inhibitor | Reinjection Well |
| West R-322 | Corrosion Inhibitor | Production Well |
| Midland 203 | Oxygen Scavenger | Reinjection and Production Well |
| Millsperse (R) 802 | Antiscalant | Reinjection Well |
| Sodium Hydroxide | pH Adjustor | Production Well |

(e) Prohibited From Reinjection:

There shall be no reinjection disposal of fluids other than the geothermal fluid, reinjection supplement water, and chemical additions for the control of corrosion and scaling as described in this permit. Furthermore, there shall be no reinjection disposal of:

- Hazardous wastes as defined in Title 40, Code of Federal Regulations (CFR), Part 261;

- Domestic wastewater as defined in Hawaii Administrative Rules, Title 11, Chapter 62, "Wastewater Systems"; and

- Any designed chemical addition to the geothermal fluid unless recognized and approved by this permit.

PERMIT ISSUED
Date OCT 21 1992

B. MONITORING AND REPORTING REQUIREMENTS:

1. Injectate and Reinjection Well Monitoring

(a) Samples and measurements taken as required herein shall be representative of the volume and nature of the geothermal fluid and reinjection supplement water.

Detailed records of the operation of the reinjection wells shall be kept by the operator. Records shall include, but not be limited to, the following information:

(1) Type of injectate.
(2) Quantity of injectate.
(3) The method of reinjection.
(4) The rate of reinjection.
(5) Reinjection pressure for wells situated in caprock areas overlying volcanic aquifers under artesian pressure.
(6) The exact date and time of the measurement.
(7) The person(s) who performed the measurement.
(8) The dates the analyses were performed.
(9) The person(s) who performed the analyses.
(10) The analytical techniques or methods used.
(11) The results of all required analyses and permit limits.

(b) A daily record of the injectate quantity being discharged into the reinjection wells shall be maintained. Injectate quantity recordings shall be continuously made with the use of instruments that directly measure and record the flow of the injectate.

(c) A continuous recording of the reinjection well head pressure and any gas blanket pressure shall be maintained. Pressure recordings shall be documented on a graphical chart, such as a strip chart or circular chart, that shows the relationship between pressure and elapse time. The pressure recordings shall be maintained whether or not the reinjection well is in use. The pressure recordings shall distinguish between the time periods of use and nonuse, if any.

(d) When reinjection supplement water is being used, a record of the reinjection supplement water quantity being discharge into the reinjection wells shall be maintained. The recordings shall be continuously made with the use of instruments that directly measure the flow of the supplement water.

(e) A record of the amount and type of chemical additions being used as specified in Part I. A. 3. (d) shall be maintained. The record shall account for the daily, weekly and monthly consumptive rates. A summary report shall be submitted to the Department every thirty (30) days (monthly) showing the consumptive figures and describing the points of application within the geothermal fluid flow system.

PERMIT ISSUED
Date OCT 21 1992

(f) Representative grab samples (three types) of the injectate shall be collected from a collection point to be established by the facility and approved by the Department. The collection and analysis of the samples shall be conducted by a laboratory which has been approved by the Department. If the laboratory is unable to perform the sample collection, the Department may allow the facility to collect the sample under the direction of the laboratory. All samples shall be collected, preserved, and documented in accordance with EPA or EPA equivalent standards. The falsification, fabrication, or tampering of the samples, chain of custody form, or analytical results shall be a violation of this permit. Methods of analysis shall be as stated herein or approved by the Department. The frequency of sample collection and the type of analyses are as described:

Type I Sample:

(1) Type I samples shall be collected and analyzed at least once every 30 days.
(2) Type I samples shall be analyzed for the chemical parameters listed in Table No. 1.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type II Sample:

(1) Type II samples shall be collected and analyzed at least once every 90 days in conjunction with Type I samples.
(2) Type II samples shall be analyzed for Ignitability, Corrosivity, Reactivity, and Method 1311: Toxicity Characteristic Leaching Procedure (TCLP) as described in 40 CFR, Part 261, Appendix II. Reference is hereby made to Table No. 3 which lists the chemical parameters for which the analysis shall be conducted under Method 1311. Regulatory levels of the chemical parameters are listed for reference.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type III Sample:

(1) Type III samples shall be collected and analyzed at least once every 90 days in conjunction with Type I and Type II samples.
(2) Type III samples shall be analyzed for volatile organic compounds as described in 40 CFR, Part 136, Appendix A, Method 624. Reference is hereby made to Table No. 4 which lists the chemical parameters for which the analysis shall be conducted under Method 624.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

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Date OCT 21 1992

(g) The collection of Type II and Type III samples shall be witnessed by the Department. The permittee shall notify the Department at least seven (7) days prior to the date of sample collection for this phase of analysis. Any Type II and Type III samples that are collected without the acknowledgement and inspection by the Department will not serve to comply with the monitoring and reporting requirements of this permit.

(h) A periodic recorded inspection of the reinjection wells at least once per 7 days shall be conducted by the facility. The inspection shall include the recordation of the operational status of the reinjection wells to detect any deterioration of the reinjection wells and associated operations that might lead to a reinjection well failure, and provide the opportunity to correct any occurrence of prohibited discharge activity. The person conducting the periodic inspection shall be acutely aware of the unlawful disposal of chemical compounds, petroleum products or other hazardous substances into the reinjection wells. If such activities are encountered, the permittee shall take immediate action to alleviate and correct such unlawful disposal.

(i) A periodic status report shall be conducted at least once every 90 days regarding the performance of the reinjection wells. The status report shall be made by a professional consultant, engineer, or geologist proficient in geothermal reinjection practices and geothermal energy production. The status report shall document the performance of the reinjection wells and shall follow the Department's guidelines for a reinjection well status report. The status reports shall be submitted to the Department for review after each report is completed.

2. Reporting of Noncompliance of Reinjection Limitations

The permittee shall notify the Department of any exceedance of the limitations specified in Part I. A. 3., Reinjection Limitations, as determined by the monitoring and analyses specified in this permit. The notification shall consist of a report that shall include the monitoring and analytical results, and an explanation for the exceedance. The report shall be submitted to the Department within fifteen (15) days of knowledge of the exceedance.

3. Upset Condition

(a) In the event of an upset of facility operations that would require the discharge of geothermal injectate to a holding system, such as a lined surface impoundment, a daily record of the quantity being discharged into the holding system shall be maintained. Discharge quantity recordings shall be continuously made with the use of instruments that directly measure the flow of the effluent.

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(b) The Department shall be notified within 24 hours of any such discharge to a holding system.

(c) A summary report of the daily discharges to the holding system, resulting from each upset event, shall be submitted to the Department within 15 days after the cessation of the upset event.

(d) The Department shall be notified of the intent to discharge the contents of the holding system into the reinjection well. Discharge into the reinjection well shall only occur with the approval of the Department.

(e) Discharges of geothermal injectate to a holding system does not preclude the implementation of all sampling, analyses, and reporting conditions of this permit.

4. Additional Monitoring and Reporting

If the operation of the reinjection wells is additionally regulated by other pollution control programs, e.g., National Pollutant Discharge Elimination System (NPDES), the adherence to those monitoring and reporting requirements shall be considered a requirement of this permit.

5. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained on site for a minimum of three (3) years from the date of the sample and shall be made available for inspection by the Director. This period may be extended by the request of the Director at any time.

6. Anticipated Changes

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may change any operating characteristics or conditions of the reinjection wells; or which may result in noncompliance with the permit conditions.

7. Notification of Change in Ownership or Control

In the event of any change in ownership or control of the reinjection wells, the owner shall report the change to the Director in writing at least one month prior to closing. Until such time as the permit is revoked and/or reissued, the permittee of record shall be responsible for the operation of the reinjection wells and for damages resulting from improper operation of the reinjection wells.

PERMIT ISSUED
Date OCT 21 1992

8. Twenty-Four Hour Reporting

The permittee shall report any deviation from the permit, including:

(a) Any monitoring, or other information, which indicates that any contaminant may cause an endangerment to a USDW; or

(b) Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between USDWs.

Such information shall be provided orally within 24 hours or the next business day of the Department from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five (5) days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance.

Oral reports shall be made to the Safe Drinking Water Branch at (808)586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258. In addition, for neighbor island occurrences, the Safe Drinking Water Branch Sanitarian shall be notified at (808)933-4552. The Director may waive the written report on a case-by-case basis if the oral report has been received immediately.

9. Definitions

(a) The "Department" means the Department of Health, State of Hawaii.

(b) The "Director" means the Director of Health or a duly authorized representative.

(c) "Facility or activity" means any UIC "reinjection well" or any other facility or activity that is subject to regulation under the UIC Program.

(d) "Fluid" means any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or any other form or state.

(e) "Reinjection well" means a "well" into which "fluids" are being emplaced or reinjected.

(f) "Reinjection pressure" means the head increase in the well bore with respect to static groundwater level.

(g) "USDW" means "underground source of drinking water" as defined in Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control.

**PERMIT ISSUED**
**Date** OCT 21 1992

A. MANAGEMENT REQUIREMENTS:

1. Change in Discharge

All operations of the reinjection wells authorized herein shall be consistent with the terms and conditions of this permit. The operation of the reinjection wells identified in this permit at volumes in excess of that authorized shall constitute a violation of the permit conditions. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new UIC application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be revoked or modified to specify and limit any pollutants not previously limited.

2. Signatory Requirements

All reports or information submitted to the Director shall be signed and certified in accordance with Title 11, Chapter 23, Underground Injection Control, Section 12(b), Hawaii Administrative Rules.

3. Availability of Reports

All reports prepared in accordance with the terms of this permit shall be available for public inspection, with the approval of the Director, at the offices of the Director. Permit applications, permits, and well operation data shall not be considered confidential.

4. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to operate the reinjection wells. Proper operation and maintenance include, but are not limited to, effective performance, adequate funding, adequate operator staffing and training, adequate laboratory and process controls, including appropriate quality assurance procedures.

PERMIT ISSUED
Date OCT 21 1992

5. Reapplication

If the permittee desires to continue an activity regulated by this permit after the expiration date of this permit, reapplication shall be made on the application forms then in use. This reapplication should be made not later than 180 days before this permit expires in order to facilitate processing of the renewal.

6. Abandonment Requirements

The owner who wishes to abandon the reinjection wells shall submit an application containing the details of the proposed abandonment. The Department will review the application and may require an abandoned well to be plugged in a manner which will not allow detrimental movement of fluids between formations. Abandonment procedures shall also comply with other applicable regulations of the Department of Land and Natural Resources.

B. GENERAL CONDITIONS

1. Operating Conditions

(a) No reinjection wells shall be operated, modified or otherwise utilized without a UIC permit issued by the Department.

(b) No person shall construct, operate, maintain, convert, plug, abandon or conduct any other reinjection activity in a manner which allows the movement of fluid containing a contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water rule or may otherwise adversely affect the health of one or more persons.

(c) The reinjection wells shall be operated in such a manner that does not violate any of Title 11, Hawaii Administrative Rules, regulating various aspects of water quality and pollution, and Chapter 342, HRS. The rules include:

(1) Chapter 11-20, "Potable Water Systems".
(2) Chapter 11-55, "Water Pollution Control".
(3) Chapter 11-62, "Wastewater Systems".

(d) If at any time the Department learns that a reinjection well may cause a violation of primary drinking water rules, the Department shall order the owner to take such actions as may be necessary to prevent the violation, including, where required, cessation of operation of the reinjection well.

PERMIT ISSUED
Date OCT 21 1992

(e) Notwithstanding any other provision of this section, the Department shall issue a cease and desist order, effective immediately, upon receipt of information that a contaminant which is present in, or likely to enter, a system supplying water for human consumption, poses an imminent and substantial danger to the health of a person or persons.

2. Permit Issuance

A copy of this permit shall be retained by the facility and shall be made available for inspection by the Director.

This UIC permit shall not be transferable from the reinjection well owner to any other person.

This UIC permit shall be subject to revocation, suspension or revision by the Director if, after notice and opportunity for a contested hearing, it is determined that:

(a) There is a violation of any term or condition of the UIC permit; or

(b) The UIC permit was obtained by misrepresentation, or failure to fully disclose all relevant facts; or

(c) The UIC permit was willfully defaced, altered, forged or falsified; or

(d) There is a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted reinjection; or

(e) There is a failure to comply with these rules or any other applicable rules or laws.

All permit conditions will remain in effect despite the filing of a request by the permittee for a permit revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance.

3. Permit Modification

Any modification, alteration, or change to this permit shall be made only by written supplement or reissuance of the permit by the Department.

4. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

PERMIT ISSUED
Date OCT 21 1992

5. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

6. The Director shall have the right to enter premises on which any reinjection well system is located; to inspect any equipment, operation, or sampling of any reinjection well system; to take effluent samples from any reinjection well system; and to have access to and copy any record required to be kept pursuant to this permit.

7. Need to Halt or Reduce an Activity not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

8. Penalties

It shall be a violation of Chapter 11-23 for any owner or operator of a reinjection well to construct, operate, maintain or close that well unless authorized by this chapter or by a permit or order to do so. It shall also be a violation of this chapter for any owner or operator to fail to comply with all of the applicable terms of the authorization, including those relating to inspection, monitoring, record keeping, and reporting. Compliance with a corrective order shall not excuse the basic violation. Any person who violates any provision of this chapter or this permit shall be subject to the penalties provided in section 340E-8, HRS or section 11-23-21, HAR.

9. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PERMIT ISSUED
Date OCT 21 1992

A. OTHER REQUIREMENTS:

1. This permit shall be further subjected to the following provisions:

(a) The implementation of the "Hydrologic Monitoring Program" prepared by Science Applications International Corporation dated April 1990, or as modified with the written approval of the Department.

(b) The implementation of the "Production and Reinjection Well Casing Monitoring Program" prepared by Puna Geothermal Venture, completed in November 1991, or as modified with the written approval of the Department.

(c) This permit herein acknowledges that conditions affecting the Hydrologic Monitoring Program and the Production and Reinjection Well Casing Monitoring Program could warrant the reevaluation of the monitoring programs to address changing concerns. Modifications to the monitoring programs, resulting from reevaluations, shall be approved by the Department before implementation.

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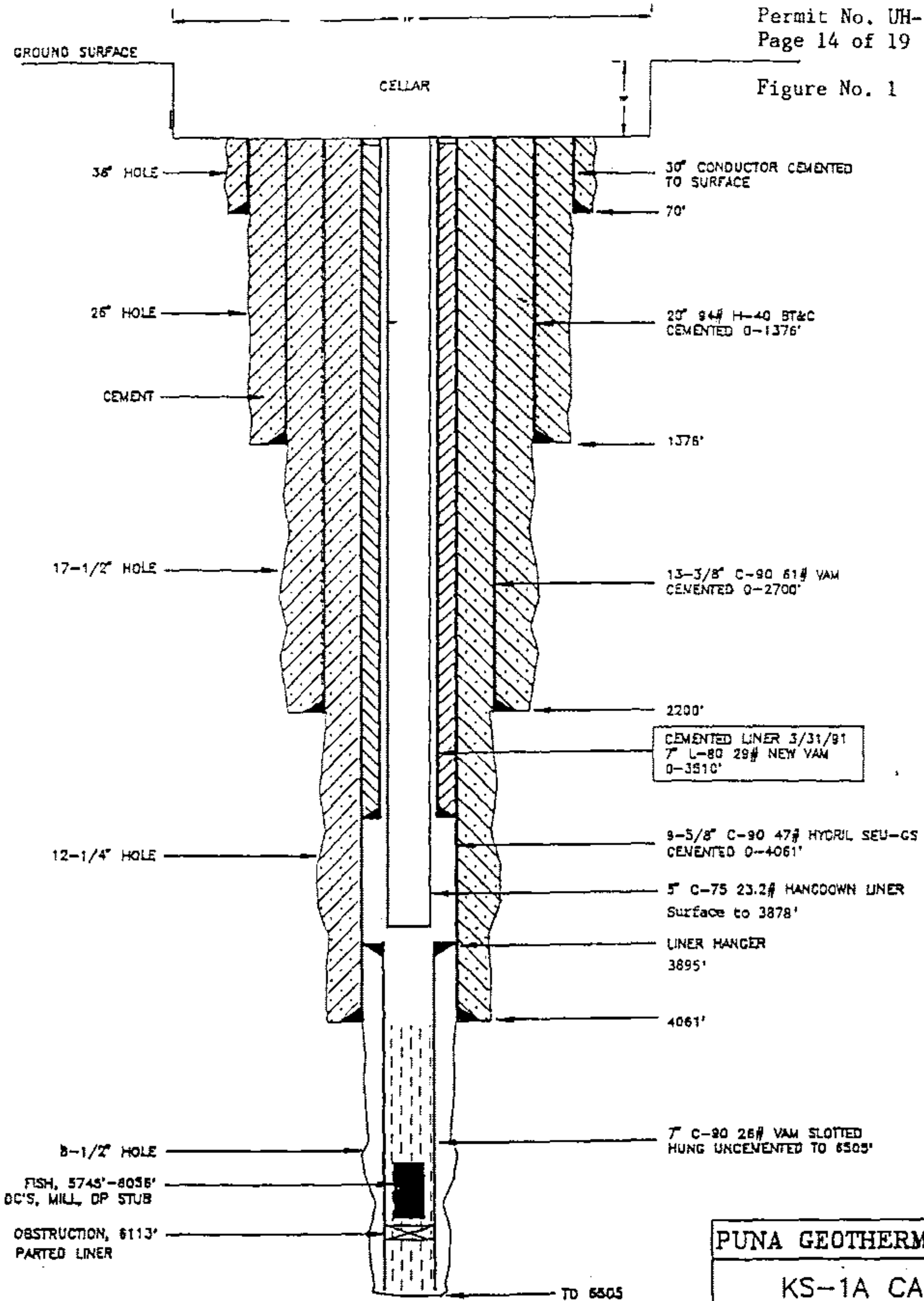
Permit No. UH-1529
Page 14 of 19

Figure No. 1 (KS-1A)




PUNA GEOTHERMAL VENTURE

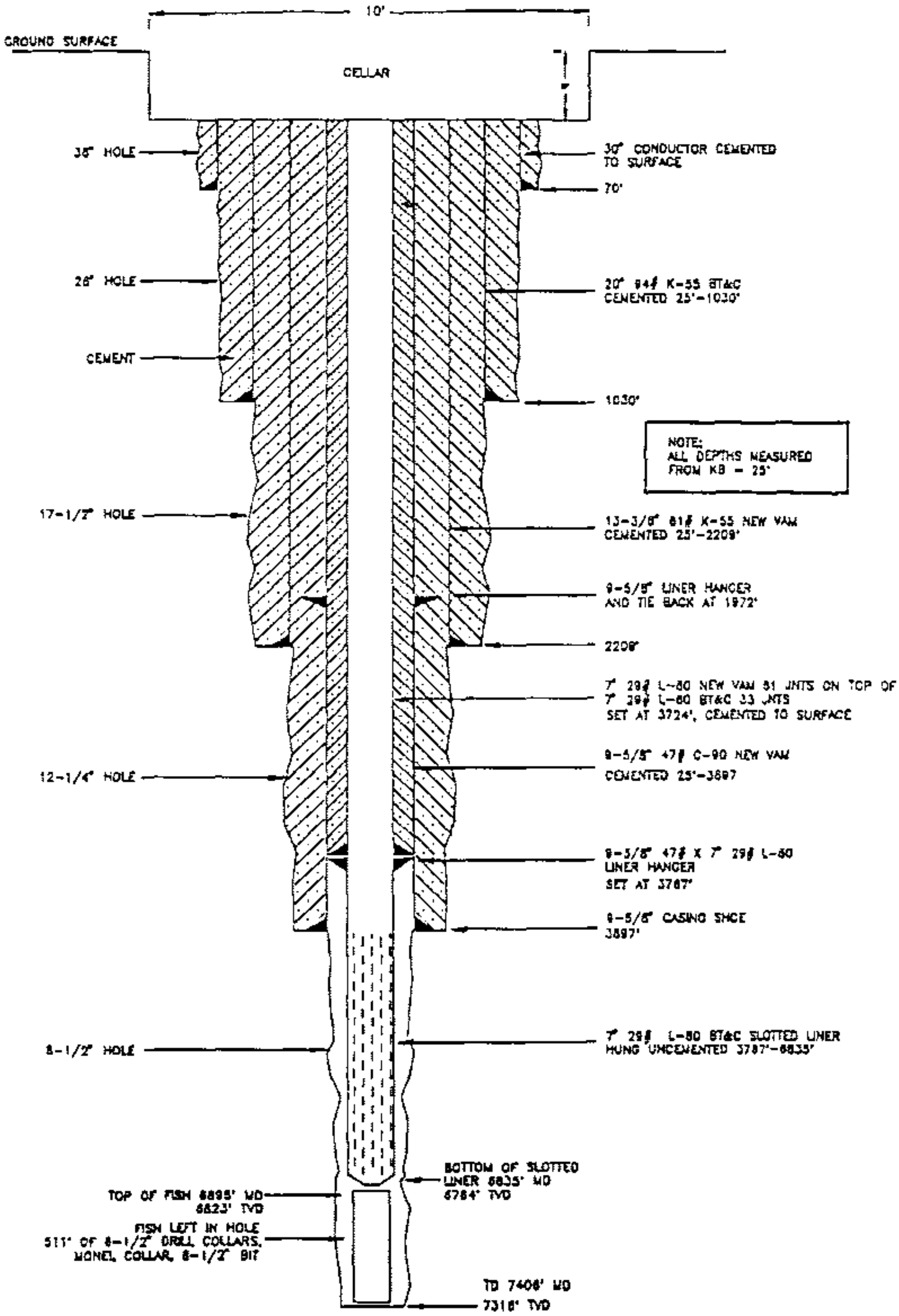
KS-1A CASING SCHEMATIC AFTER REWORK AS OF 10/14/92

| | | |
|---|---|---|
| BY W. TEPLOW | FILE: KS1ACAS.DWG | FIGURE NO. 1 |

PERMIT ISSUED
Date OCT 21 1992

Figure No. 2
(KS-3)






PUNA GEOTHERMAL VENTURE

KS-3 COMPLETION
AS OF 10/3/92

REV. 2

FIGURE NO. 2

PERMIT ISSUED
Date OCT 21 1992

TABLE NO. 1

GEOTHERMAL LIQUID PARAMETERS

| | | | |
|---|---|---|---|
| Li | Lithium | S | Sulfur |
| Na | Sodium | Se | Selenium |
| K | Potassium | F | Fluorine |
| Mg | Magnesium | Cl | Chlorine |
| Ca | Calcium | Br | Bromine |
| Ba | Barium | I | Iodine |
| V | Vanadium | | |
| Cr | Chromium | $NH_3$ | Ammonia |
| Mn | Manganese | $SO_4$ | Sulfate |
| Fe | Iron | $NO_4$ | Nitrate |
| Ni | Nickel | $HCO_3$ | Bicarbonate |
| Cu | Copper | $CO_3$ | Carbonate |
| Ag | Silver | $SiO_2$ | (Silica) |
| Zn | Zinc | | |
| Cd | Cadmium | TDS | Total Dissolved Solids |
| Hg | Mercury | TSS | Total Suspended Solids |
| B | Boron | | Total Alkalinity |
| Pb | Lead | | Conductivity |
| As | Arsenic | | Density |
| | | | pH |
| | | | Oil & Grease |

GEOTHERMAL NON-CONDENSIBLE GAS PARAMETERS

| | |
|---|---|
| $CO_2$ | Carbon Dioxide |
| $H_2S$ | Hydrogen Sulfide |
| $NH_3$ | Ammonia |
| Ar | Argon |
| $N_2$ | Nitrogen |
| $CH_4$ | Methane |
| He | Helium |
| $H_2$ | Hydrogen |

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Date OCT 21 1992

TABLE NO. 2

CHEMICAL ADDITIONS FOR THE CONTROL OF CORROSION, SCALING AND PH

| Product Name | Chemical Ingredient |
|---|---|
| Amersite (R)2 | Sodium Bisulfite |
| Wrico Oxy 11 | Sodium Sulfite<br>Ethylenediaminetetraacetic Acid Sodium Salt |
| WPD 11-306 (Tm) | Dimethyldioctylammonium Chloride<br>Soya Amine Polyethoxylate<br>Cyclohexylamine |
| West R-322 | Polyamidoamino Acetate<br>POE (15) Tallow Amine |
| Midland 203 | Sodium Metabisulfite<br>Cobalt Compounds |
| Millsperse (R) 802 | Poly (Maleic Acid) |
| Sodium Hydroxide | Sodium Hydroxide (Na OH) |

PERMIT ISSUED
Date OCT 21 1992

TABLE NO. 3

TYPE II SAMPLE CHEMICAL PARAMETERS

| Chemical Parameter | Regulatory Level (mg/l) | Method |
|---|---|---|
| Ignitability | | |
| Corrosivity | | |
| Reactivity | | |
| Inorganics: | | 1311 |
| arsenic | 5.0 | |
| barium | 100.0 | |
| cadmium | 1.0 | |
| chromium | 5.0 | |
| lead | 5.0 | |
| mercury | 0.2 | |
| selenium | 1.0 | |
| silver | 5.0 | |
| Organics: | | 1311 |
| benzene | 0.5 | |
| carbon tetrachloride | 0.5 | |
| chlorobenzene | 100.0 | |
| chloroform | 6.0 | |
| o-cresol | 200.0 | |
| m-cresol | 200.0 | |
| p-cresol | 200.0 | |
| 1,4-dichlorobenzene | 7.5 | |
| 1,2-dichloroethane | 0.5 | |
| 1,1-dichloroethylene | 0.7 | |
| 2,4-dinitrotoluene | 0.13 | |
| hexachlorobenzene | 0.13 | |
| hexachloro-1,3-butadiene | 0.5 | |
| hexachloroethane | 3.0 | |
| methyl ethyl ketone | 200.0 | |
| nitrobenzene | 2.0 | |
| pyridine | 5.0 | |
| tetrachloroethylene | 0.7 | |
| trichloroethylene | 0.5 | |
| vinyl chloride | 0.2 | |

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Date OCT 21 1992

TABLE NO. 4

TYPE III SAMPLE CHEMICAL PARAMETERS

| Chemical Parameter | Method |
| --- | --- |
| Volatile Organics: | 8240 (624) |
| Bromodichloromethane | |
| Bromoform | |
| Bromomethane | |
| Chloroethane | |
| 2-Chloroethylvinyl ether | |
| Chloromethane | |
| Dibromochloromethane | |
| 1,2-Dichlorobenzene | |
| 1,3-Dichlorobenzene | |
| 1,1-Dichloroethane | |
| trans-1,2-Dichloroethene | |
| 1-2-Dichloropropane | |
| cis-1,3-Dichloropropene | |
| trans-1,3-Dichloropropene | |
| Ethyl benzene | |
| Methylene chloride | |
| 1,1,2,2-Tetrachloroethane | |
| Toulene | |
| 1,1,1-Trichloroethane | |
| 1,1,2-Trichloroethane | |
| Trichlorofluoromethane | |

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Date OCT 21 1992

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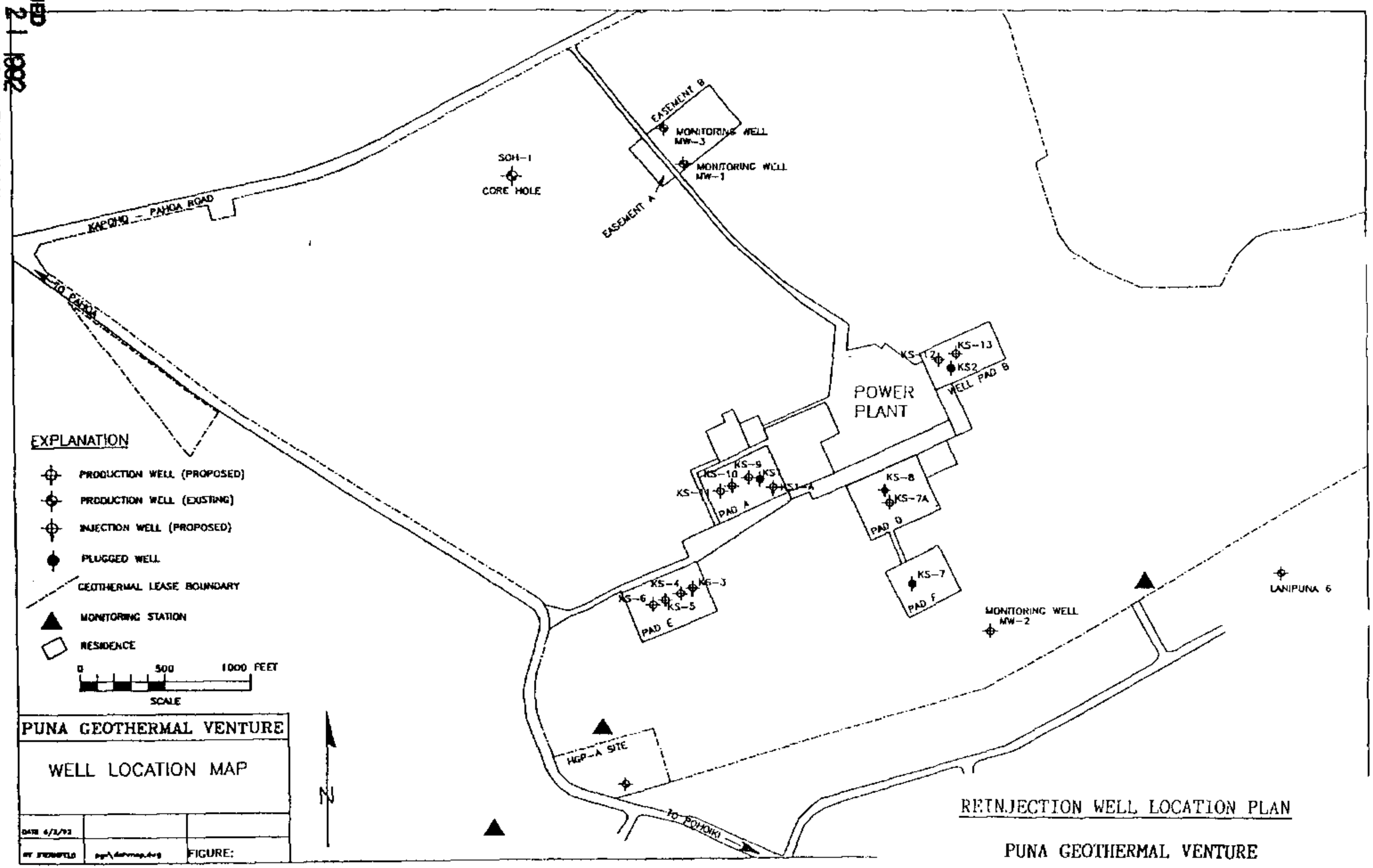
Date OCT 21 1992




REINJECTION WELL LOCATION PLAN

PUNA GEOTHERMAL VENTURE

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii

UIC Permit No. UH-1529

JOHN WAIHEE
GOVERNOR OF HAWAII

RECEIVED
92 AUG 4 P 3:52
DIV. OF WATER & LAND DEVELOPMENT

RECEIVED
92 JUL 31 A 8:09
DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

STATE OF HAWAII
DEPARTMENT OF HEALTH
P. O. BOX 3378
HONOLULU, HAWAII 96801

JOHN C. LEWIN, M.D.
DIRECTOR OF HEALTH

In reply, please refer to:
EMD / SDWB

July 27, 1992

**CERTIFIED MAIL**
**RETURN RECEIPT REQUESTED**

Mr. Steven E. Morris
Vice President and General Manager
Puna Geothermal Venture
P. O. Box 30
Pahoa, Hawaii 96778

Dear Mr. Morris:

SUBJECT: PUNA GEOTHERMAL VENTURE
UNDERGROUND INJECTION CONTROL (UIC)
UIC APPLICATION NO. UH-1529

The Department of Health has completed its review of your UIC application. It has been determined that the conditions required for the granting of approval to operate two (2) injection wells at the subject facility have been satisfied. Therefore, you are hereby granted approval to operate the two (2) injection wells under the terms and conditions of the enclosed permit.

Your facility and injection wells have been assigned the following identification numbers:

**UIC Permit No. UH-1529**
**Facility ID No. 8-2883.01**
**Well No. KS-1A and KS-3**

Please refer to these identification numbers, along with your UIC permit number, in all future correspondence with this office.

Failure to comply with the terms and conditions of the permit will constitute a violation of the permit. Any person who violates the permit requirements or any provision of Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control, shall be subject to the penalties provided in Section 340E-8, Hawaii Revised Statutes.

If you have any questions regarding your permit, or the UIC Program, please contact Chauncey Hew of the Safe Drinking Water Branch at 586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258.

Sincerely,

Thomas E. Arizumi

THOMAS E. ARIZUMI, P.E., Chief
Environmental Management Division

CH:kt

Enclosure: UIC Permit

c: 1. Glenn Tomori, SDWB Sanitarian, Hilo (w/encl. of Permit)
2. Norman Hayashi, Planning Department, County of Hawaii (w/encl. of Permit)
✓ 3. William Paty, DLNR (w/encl. of Permit)
4. Murray Towill, DBEDT (w/encl. of Permit)
5. Clarence Tenley, EPA (w/encl. of Permit)

**PERMIT ISSUED**

Date 27 1992

**AUTHORIZATION TO OPERATE UNDER THE**
**UNDERGROUND INJECTION CONTROL PROGRAM**

In compliance with the provisions of the Safe Drinking Water Act, Chapter 340E, Hawaii Revised Statutes (HRS), as amended, and Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control;

PUNA GEOTHERMAL VENTURE

is authorized to operate a Class V, Subclass B, geothermal reinjection well system consisting of two (2) reinjection wells; known as geothermal wells Kapoho State 1A (KS-1A) and Kapoho State 3 (KS-3):

| Reinjection Well No. | Located on Well Pad | Approx. Wellhead Elevation Above Mean Sea Level |
|---|---|---|
| KS-1A | A | 617 feet |
| KS-3 | E | 618 feet |

and having the specifications as listed in Figure No. 1 and Figure No. 2, respectively; to reinject the geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal noncondensible gases which are produced during the operation of the well field and power plant; and the intermittent inclusion of reinjection supplement water; back into the geothermal reservoir at an interval between the approximate depths of 3,900 feet and 7,300 feet;

located at the facility's address of 14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778; at Tax Key Number, 3rd Div. 1-4-01:2 and 19; at the approximate well pad coordinates:

Well Pad A: Latitude 19° 28′ 49" N and Longitude 154° 53′ 35" W;
Well Pad E: Latitude 19° 28′ 41" N and Longitude 154° 53′ 40" W;

in accordance with monitoring requirements and other conditions set forth in Parts I, II and III hereof.

This permit will become effective upon issuance.

This permit and the authorization to operate the reinjection wells will expire at midnight, July 26, 1995.

Issued on the 27th day of July 1992.

PERMIT ISSUED
Date JUL 27 1992

Thomas E. Arizumi
(For) Director of Health

A. THE OPERATION OF THE REINJECTION WELLS SHALL BE LIMITED TO:

1. Injectate Characteristics

The reinjection of geothermal fluids consisting of geothermal brine, geothermal steam condensate, geothermal noncondensible gases and reinjection supplement water that may include the chemical parameters as listed in Table No. 1 as being representative of the geothermal fluid.

2. Reinjection Limitations

(a) Reinjection Pressure:
The reinjection pressure as measured at the well head shall not exceed 500 psi gauge or the fracture pressure of the receiving formation, whichever is less.

(b) Reinjection Quantity and Rate:

The reinjection quantity and rate shall be commensurate with the production of up to twenty-five (25) megawatts, net power.

The reinjection rate shall be limited to a total of approximately 675,000 lbs./hr., or to a rate commensurate with the reinjection capacity of the reinjection wells, whichever is less. The approximate composition of the injectate based on 675,000 lbs./hr. is:

| | |
|---|---|
| Steam Condensate | 505,816 lbs./hr. |
| Brine | 128,250 lbs./hr. |
| Supplement Water and/or Brine from the Storage Pits | 39,751 lbs./hr. |
| Total Noncondensible Gases | 1,183 lbs./hr. |
| Total | 675,000 lbs./hr. |

(c) Concentrations of the Effluent:

The concentrations of the chemical parameters of the geothermal fluid listed in Table No. 1 are recognized as being variable and peculiar to the geothermal resource and the processes of geothermal energy production. Therefore, concentrations as such, for the purpose of setting maximum chemical levels, are not listed in this permit; however, chemical analyses are required as detailed in Part I, Section B of this permit.

(d) Prohibited From Reinjection:

There shall be no reinjection disposal of fluids other than the geothermal fluid and reinjection supplement water as described in Part I, Section A.1. Furthermore, there shall be no reinjection disposal of:

- Hazardous wastes without the prior written authorization of the Director;

- Domestic wastewater as defined in Hawaii Administrative Rules, Title 11, Chapter 62, "Wastewater Systems"; and

- Any designed chemical inclusion to the geothermal fluid unless recognized and approved by this permit.

PERMIT ISSUED
Date JUL 27 1992

B. MONITORING AND REPORTING REQUIREMENTS:

1. Injectate and Reinjection Well Monitoring

(a) Samples and measurements taken as required herein shall be representative of the volume and nature of the geothermal fluid and reinjection supplement water.

Detailed records of the operation of the reinjection wells shall be kept by the operator. Records shall include, but not be limited to, the following information:

(1) Type of injectate;
(2) Quantity of injectate;
(3) The method of reinjection;
(4) The rate of reinjection;
(5) Reinjection pressure for wells situated in caprock areas overlying volcanic aquifers under artesian pressure.
(6) The exact date and time of the measurement;
(7) The person(s) who performed the measurement;
(8) The dates the analyses were performed;
(9) The person(s) who performed the analyses;
(10) The analytical techniques or methods used;
(11) The results of all required analyses and permit limits;

(b) A daily record of the injectate quantity being discharged into the reinjection wells shall be maintained. Injectate quantity recordings shall be continuously made with the use of instruments that directly measure and record the flow of the injectate.

(c) When reinjection supplement water is being used, a record of the reinjection supplement water quantity being discharge into the reinjection wells shall be maintained. The recordings shall be continuously made with the use of instruments that directly measure the flow of the supplement water.

(d) Representative samples (three types) of the injectate shall be collected from a collection point to be established by the facility and approved by the Department, and analyzed as described:

Type I Sample:

(1) Type I samples shall be collected and analyzed at least once every 30 days.
(2) Type I samples shall be analyzed for the chemical parameters listed in Table No. 1.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

PERMIT ISSUED
Date JUL 27 1992

Type II Sample:

(1) Type II samples shall be collected and analyzed at least once every 90 days.
(2) Type II samples shall be analyzed for Ignitability, Corrosivity, Reactivity, and Method 1311: Toxicity Characteristic Leaching Procedure (TCLP) as described in 40 CFR, Part 261, Appendix II. Reference is hereby made to Table No. 2 which lists the chemical parameters for which analysis shall be conducted under Method 1311. Regulatory levels of the chemical parameters are listed for reference.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type III Sample:

(1) Type III samples shall be collected and analyzed at least once every 90 days.
(2) Type III samples shall be analyzed for volatile organic compounds as described in 40 CFR, Part 136, Appendix A, Method 624.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

(e) Laboratory analysis shall be conducted by a laboratory approved by the Department. Methods of analysis shall be as stated herein or approved by the Department.

(f) Regarding sample Type II and Type III, the permittee shall notify the Department at least seven (7) days prior to the date of sample collection. Any Type II and Type III samples which are collected without the acknowledgement and inspection by the Department will not serve to comply with the monitoring and reporting requirements of this permit.

(g) A reinjection well status report shall be submitted to the Department at least once every 90 days. The reinjection well status report shall describe the performance of the reinjection well and shall be the basis for the facility to establish continuous performance monitoring. The report shall be made by a professional engineer or geologist proficient in geothermal reinjection practices and geothermal energy production.

PERMIT ISSUED
Date JUL 2 7 1992

2. Upset Condition

(a) In the event of an upset of facility operations that would require the discharge of geothermal injectate to be diverted from the reinjection well to any other ground disposal system, such as a surface impoundment, a daily record of the quantity being discharged into the disposal system shall be maintained. Discharge quantity recordings shall be continuously made with the use of instruments that directly measure the flow of the effluent.

(b) A summary of the daily discharges resulting from each upset event shall be submitted to the Department within 15 days after the cessation of the upset event.

(c) Discharges of geothermal injectate to any ground disposal system does not preclude the implementation of all sampling, analyses, and reporting conditions of this permit.

3. Additional Monitoring and Reporting

If the operation of the reinjection wells is additionally regulated by other pollution control programs, e.g., National Pollutant Discharge Elimination System (NPDES), the adherence to those monitoring and reporting requirements shall be considered a requirement of this permit.

4. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained on site for a minimum of three (3) years from the date of the sample and shall be made available for inspection by the Director. This period may be extended by the request of the Director at any time.

5. Anticipated Changes

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may change any operating characteristics or conditions of the reinjection wells; or which may result in noncompliance with the permit conditions.

6. Notification of Change in Ownership or Control

In the event of any change in ownership or control of the reinjection wells, the owner shall report the change to the Director in writing at least one month prior to closing. Until such time as the permit is revoked and/or reissued, the permittee of record shall be responsible for the operation of the reinjection wells and for damages resulting from improper operation of the reinjection wells.

**PERMIT ISSUED**
Date JUL 27 1992

7. Twenty-Four Hour Reporting

The permittee shall report any deviation from the permit, including:

(a) Any monitoring, or other information, which indicates that any contaminant may cause an endangerment to a USDW; or

(b) Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between USDWs.

Such information shall be provided orally within 24 hours or the next business day of the Department from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five (5) days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance.

Oral reports shall be made to the Safe Drinking Water Branch at (808)586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258. In addition, for neighbor island occurrences, the Safe Drinking Water Branch Sanitarian shall be notified at (808)933-4552. The Director may waive the written report on a case-by-case basis if the oral report has been received immediately.

8. Definitions

(a) The "Department" means the Department of Health, State of Hawaii.

(b) The "Director" means the Director of Health or a duly authorized representative.

(c) "Facility or activity" means any UIC "reinjection well" or any other facility or activity that is subject to regulation under the UIC Program.

(d) "Fluid" means any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or any other form or state.

(e) "Hazardous waste" means the same as defined in Section 342J-2, Hawaii Revised Statutes, and state administrative rules.

(f) "Reinjection well" means a "well" into which "fluids" are being emplaced or reinjected.

(g) "Reinjection pressure" means the head increase in the well bore with respect to static groundwater level.

(h) "USDW" means "underground source of drinking water" as defined in Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control.

PERMIT ISSUED
Date JUL 27 1992

A. MANAGEMENT REQUIREMENTS:

1. Change in Discharge

All operations of the reinjection wells authorized herein shall be consistent with the terms and conditions of this permit. The operation of the reinjection wells identified in this permit at volumes in excess of that authorized shall constitute a violation of the permit conditions. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new UIC application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be revoked or modified to specify and limit any pollutants not previously limited.

2. Signatory Requirements

All reports or information submitted to the Director shall be signed and certified in accordance with Title 11, Chapter 23, Underground Injection Control, Section 12(b), Hawaii Administrative Rules.

3. Availability of Reports

All reports prepared in accordance with the terms of this permit shall be available for public inspection, with the approval of the Director, at the offices of the Director. Permit applications, permits, and well operation data shall not be considered confidential.

4. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to operate the reinjection wells. Proper operation and maintenance include, but are not limited to, effective performance, adequate funding, adequate operator staffing and training, adequate laboratory and process controls, including appropriate quality assurance procedures.

5. Reapplication

If the permittee desires to continue an activity regulated by this permit after the expiration date of this permit, reapplication shall be made on the application forms then in use. This reapplication should be made not later than 180 days before this permit expires in order to facilitate processing of the renewal.

6. Abandonment Requirements

The owner who wishes to abandon the reinjection wells shall submit an application containing the details of the proposed abandonment. The Department will review the application and may require an abandoned well to be plugged in a manner which will not allow detrimental movement of fluids between formations. Abandonment procedures shall also comply with other applicable regulations of the Department of Land and Natural Resources.

B. GENERAL CONDITIONS

1. Operating Conditions

(a) No reinjection wells shall be operated, modified or otherwise utilized without a UIC permit issued by the Department.

(b) No person shall construct, operate, maintain, convert, plug, abandon or conduct any other reinjection activity in a manner which allows the movement of fluid containing a contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water rule or may otherwise adversely affect the health of one or more persons.

(c) The reinjection wells shall be operated in such a manner that does not violate any of Title 11, Hawaii Administrative Rules, regulating various aspects of water quality and pollution, and Chapter 342, HRS. The rules include:

(1) Chapter 11-20, "Potable Water Systems";
(2) Chapter 11-55, "Water Pollution Control"; and
(3) Chapter 11-62, "Wastewater Systems".

(d) If at any time the Department learns that a reinjection well may cause a violation of primary drinking water rules, the Department shall order the owner to take such actions as may be necessary to prevent the violation, including, where required, cessation of operation of the reinjection well.

(e) Notwithstanding any other provision of this section, the Department shall issue a cease and desist order, effective immediately, upon receipt of information that a contaminant which is present in, or likely to enter, a system supplying water for human consumption, poses an imminent and substantial danger to the health of a person or persons.

2. Permit Issuance

A copy of this permit shall be retained by the facility and shall be made available for inspection by the Director.

This UIC permit shall not be transferable from the reinjection well owner to any other person.

This UIC permit shall be subject to revocation, suspension or revision by the Director if, after notice and opportunity for a contested hearing, it is determined that:

(a) There is a violation of any term or condition of the UIC permit; or

(b) The UIC permit was obtained by misrepresentation, or failure to fully disclose all relevant facts; or

(c) The UIC permit was willfully defaced, altered, forged or falsified; or

(d) There is a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted reinjection; or

(e) There is a failure to comply with these rules or any other applicable rules or laws.

All permit conditions will remain in effect despite the filing of a request by the permittee for a permit revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance.

3. Permit Modification

Any modification, alteration, or change to this permit shall be made only by written supplement or reissuance of the permit by the Department.

4. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

PERMIT ISSUED
Date JUL 2 7 1999

5. Property Rights

The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

6. The Director shall have the right to enter premises on which any reinjection well system is located; to inspect any equipment, operation, or sampling of any reinjection well system; to take effluent samples from any reinjection well system; and to have access to and copy any record required to be kept pursuant to this permit.

7. Need to Halt or Reduce an Activity not a Defense

It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

8. Penalties

It shall be a violation of Chapter 11-23 for any owner or operator of a reinjection well to construct, operate, maintain or close that well unless authorized by this chapter or by a permit or order to do so. It shall also be a violation of this chapter for any owner or operator to fail to comply with all of the applicable terms of the authorization, including those relating to inspection, monitoring, record keeping, and reporting. Compliance with a corrective order shall not excuse the basic violation. Any person who violates any provision of this chapter or this permit shall be subject to the penalties provided in section 340E-8, HRS or section 11-23-21, HAR.

9. Severability

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

PERMIT ISSUED
Date JUL 27 1992

A. OTHER REQUIREMENTS:

1. This permit shall be further subjected to the following provisions:

(a) The implementation of the "Hydrologic Monitoring Program" prepared by Science Applications International Coporation dated April 1990, or as modified with the written approval of the Department.

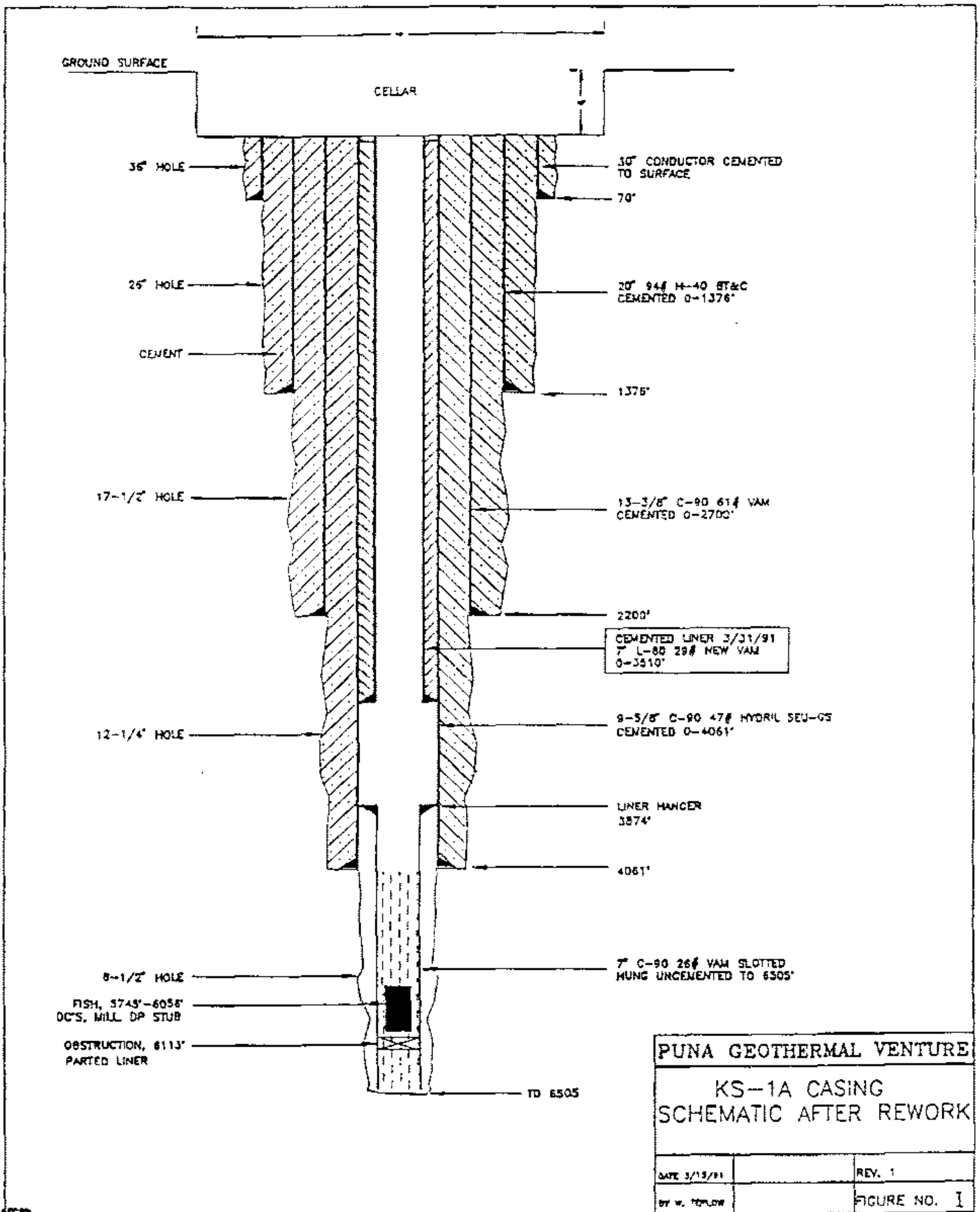
(b) The implementation of the "Production and Reinjection Well Casing Monitoring Program" prepared by Puna Geothermal Venture, completed in November 1991, or as modified with the written approval of the Department.

(c) This permit herein acknowledges that conditions affecting the Hydrologic Monitoring Program and the Production and Reinjection Well Casing Monitoring Program could warrant the reevaluation of the monitoring programs to address changing concerns. Modifications to the monitoring programs, resulting from reevaluations, shall be approved by the Department before implementation.

PERMIT ISSUED
Date JUL 27 1992

Figure No. 1

(KS-1A)



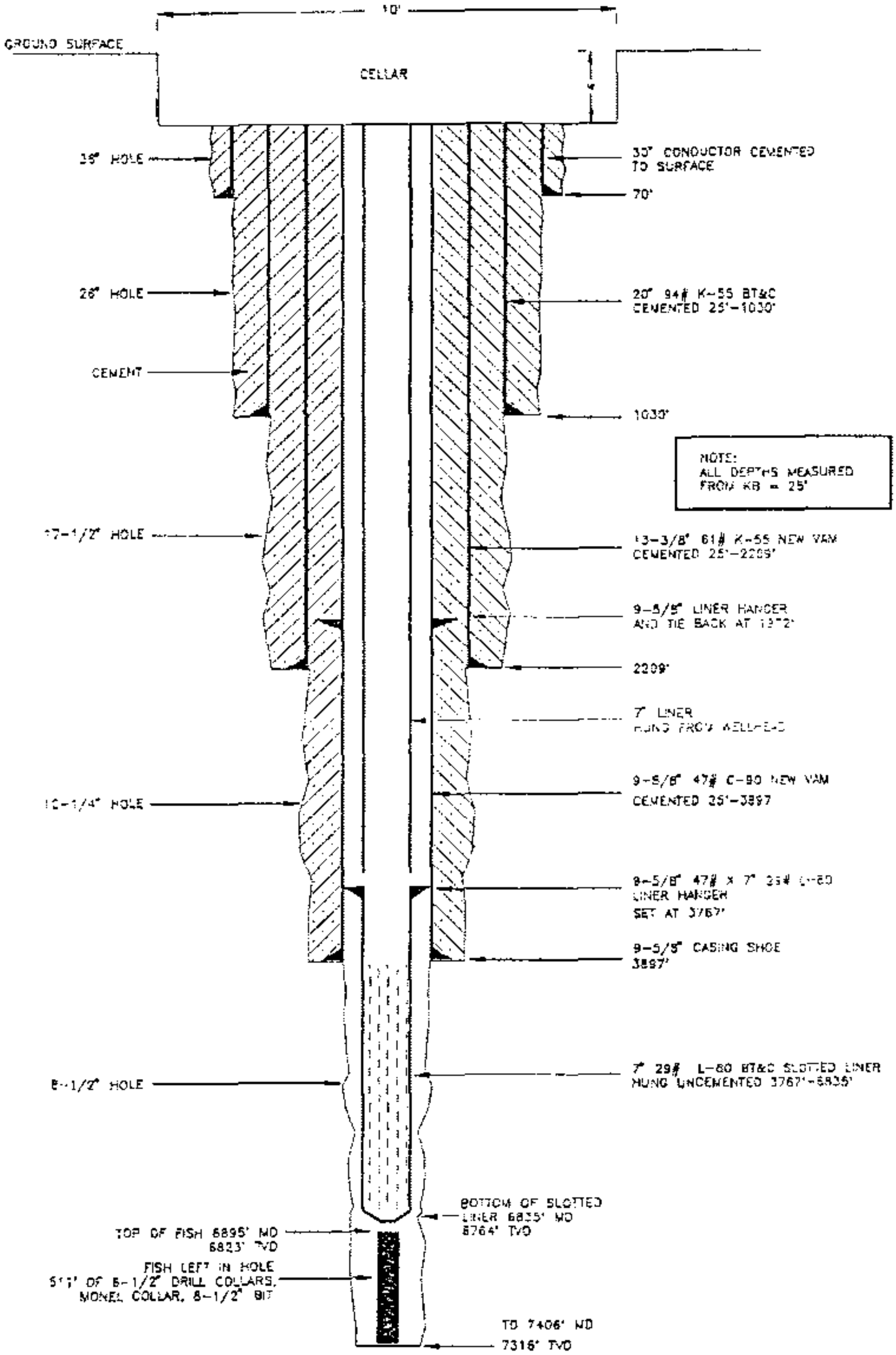

PERMIT ISSUED JUL 27 1992

Date

Figure No. 2

(KS-3)






| | | |
|---|---|---|
| PUNA GEOTHERMAL VENTURE | | |
| INJECTION WELL KS-3<br>CASING DESIGN | | |
| DATE 4/22/92 | | REV. 1 |
| BY STEPHFELD | FILE: PGV\KS3CAS.DWG | FIGURE NO. 2 |

**PERMIT ISSUED** JUL 27 1992

**Date** ____________

## TABLE NO. 1

### GEOTHERMAL LIQUID PARAMETERS

| | | | |
|---|---|---|---|
| Li | Lithium | S | Sulfur |
| Na | Sodium | Se | Selenium |
| K | Potassium | F | Fluorine |
| Mg | Magnesium | Cl | Chlorine |
| Ca | Calcium | Br | Bromine |
| Ba | Barium | I | Iodine |
| V | Vanadium | | |
| Cr | Chromium | $NH_3$ | Ammonia |
| Mn | Manganese | $SO_4$ | Sulfate |
| Fe | Iron | $NO_4$ | Nitrate |
| Ni | Nickel | $HCO_3$ | Bicarbonate |
| Cu | Copper | $CO_3$ | Carbonate |
| Ag | Silver | $SiO_2$ | (Silica) |
| Zn | Zinc | | |
| Cd | Cadmium | TDS | Total Dissolved Solids |
| Hg | Mercury | TSS | Total Suspended Solids |
| B | Boron | | Total Alkalinity |
| Pb | Lead | | Conductivity |
| As | Arsenic | | Density |
| | | | pH |
| | | | Oil & Grease |

### GEOTHERMAL NON-CONDENSIBLE GAS PARAMETERS

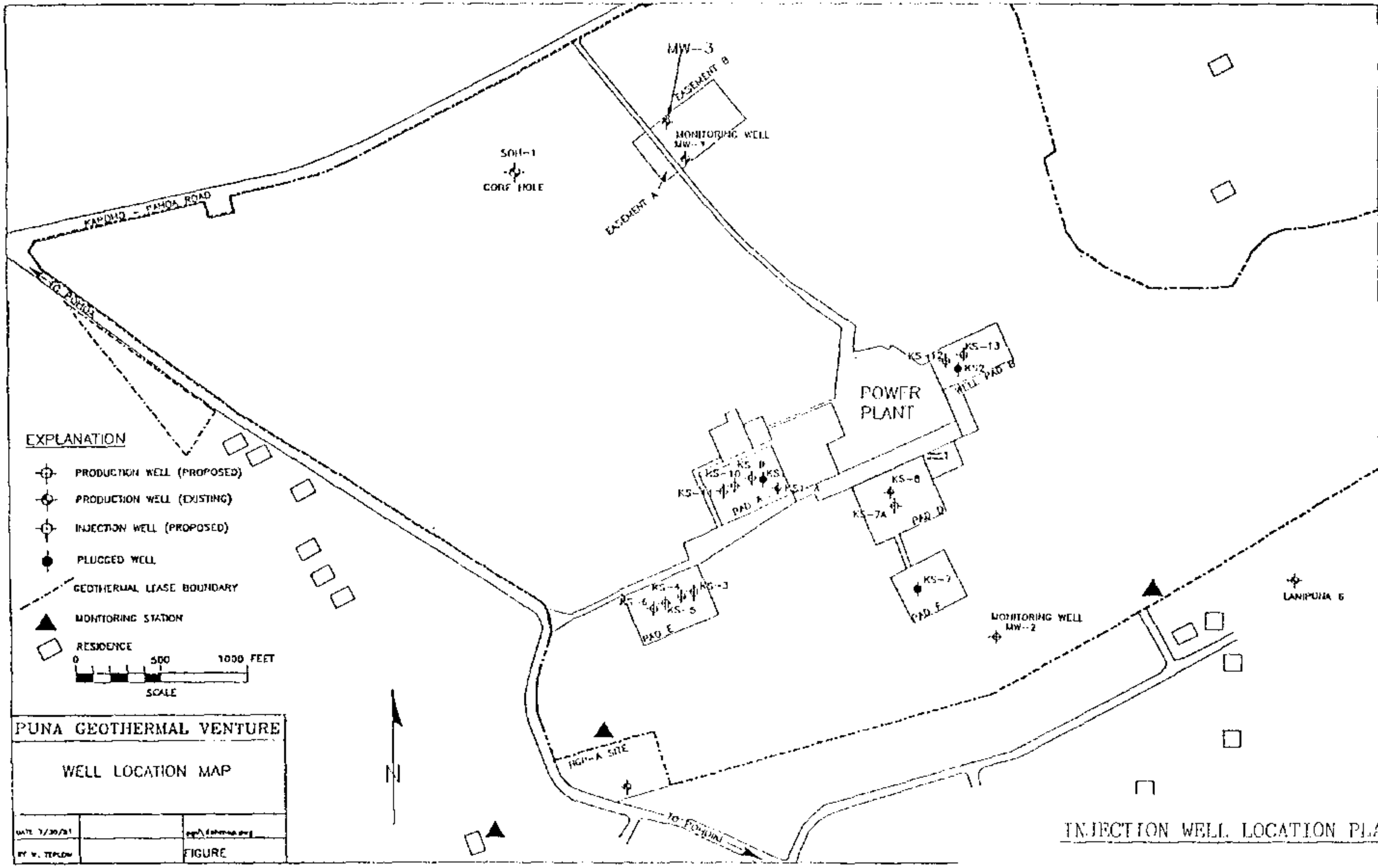
| | |
|---|---|
| $CO_2$ | Carbon Dioxide |
| $H_2S$ | Hydrogen Sulfide |
| $NH_3$ | Ammonia |
| Ar | Argon |
| $N_2$ | Nitrogen |
| $CH_4$ | Methane |
| He | Helium |
| $H_2$ | Hydrogen |

PERMIT ISSUED
Date JUL 27 1992

TABLE NO. 2

| Chemical Parameter | Regulatory Level (mg/l) |
|---|---|
| Arsenic | 5.0 |
| Barium | 100.0 |
| Cadmium | 1.0 |
| Chromium | 5.0 |
| Lead | 5.0 |
| Mercury | 0.2 |
| Selenium | 1.0 |
| Silver | 5.0 |
| | |
| Benzene | 0.5 |
| Carbon Tetrachloride | 0.5 |
| Chlorobenzene | 100.0 |
| Chloroform | 6.0 |
| 1,4 - Dichlorobenzene | 7.5 |
| 1,2 - Dichloroethane | 0.5 |
| 2,4 - Dinitrotoluene | 0.7 |
| Hexachlorobenzene | 0.13 |
| Hexachloro - 1,3 - butadiene | 0.5 |
| Hexachloroethane | 3.0 |
| Methyl Ethyl Ketone | 200.0 |
| Nitrobenzene | 2.0 |
| Tetrachloroethylene | 0.7 |
| Trichloroethylene | 0.5 |
| Vinyl Chloride | 0.2 |

PERMIT ISSUED
Date JUL 27 1992




INJECTION WELL LOCATION PLAN

PUNA GEOTHERMAL VENTURE

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii

UIC Permit No. UH-1529

**PERMIT ISSUED** JUL 27 1992

**Date**

## TABLE NO. 1

### GEOTHERMAL LIQUID PARAMETERS

| | | | |
|---|---|---|---|
| Li | Lithium | S | Sulfur |
| Na | Sodium | Se | Selenium |
| K | Potassium | F | Fluorine |
| Mg | Magnesium | Cl | Chlorine |
| Ca | Calcium | Br | Bromine |
| Ba | Barium | I | Iodine |
| V | Vanadium | | |
| Cr | Chromium | $NH_3$ | Ammonia |
| Mn | Manganese | $SO_4$ | Sulfate |
| Fe | Iron | $NO_4$ | Nitrate |
| Ni | Nickel | $HCO_3$ | Bicarbonate |
| Cu | Copper | $CO_3$ | Carbonate |
| Ag | Silver | $SiO_2$ | (Silica) |
| Zn | Zinc | | |
| Cd | Cadmium | TDS | Total Dissolved Solids |
| Hg | Mercury | TSS | Total Suspended Solids |
| B | Boron | | Total Alkalinity |
| Pb | Lead | | Conductivity |
| As | Arsenic | | Density |
| | | | pH |
| | | | Oil & Grease |

### GEOTHERMAL NON-CONDENSIBLE GAS PARAMETERS

| | |
|---|---|
| $CO_2$ | Carbon Dioxide |
| $H_2S$ | Hydrogen Sulfide |
| $NH_3$ | Ammonia |
| Ar | Argon |
| $N_2$ | Nitrogen |
| $CH_4$ | Methane |
| He | Helium |
| $H_2$ | Hydrogen |

TABLE NO. 2

| Chemical Parameter | Regulatory Level (mg/l) |
|---|---|
| Arsenic | 5.0 |
| Barium | 100.0 |
| Cadmium | 1.0 |
| Chromium | 5.0 |
| Lead | 5.0 |
| Mercury | 0.2 |
| Selenium | 1.0 |
| Silver | 5.0 |
| Benzene | 0.5 |
| Carbon Tetrachloride | 0.5 |
| Chlorobenzene | 100.0 |
| Chloroform | 6.0 |
| 1,4 - Dichlorobenzene | 7.5 |
| 1,2 - Dichloroethane | 0.5 |
| 2,4 - Dinitrotoluene | 0.7 |
| Hexachlorobenzene | 0.13 |
| Hexachloro - 1,3 - butadiene | 0.5 |
| Hexachloroethane | 3.0 |
| Methyl Ethyl Ketone | 200.0 |
| Nitrobenzene | 2.0 |
| Tetrachloroethylene | 0.7 |
| Trichloroethylene | 0.5 |
| Vinyl Chloride | 0.2 |

KS 1A

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

MANABU TAGOMORI

AQUACULTURE DEVELOPMENT PROGRAM
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LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

# GEOTHERMAL WELL CONVERSION PERMIT

Kapoho State No. 1-A (KS-1A)
Kapoho, Puna, Hawaii

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated December 9, 1991, for a permit to convert geothermal production well Kapoho State No. 1-A to an injection well is approved:

Well Designation: Kapoho State No. 1-A (KS-1A)
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii (Well Pad A)
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VIII Corporation
Ground Elevation: 620 +/- ft.
Total Depth: 6,505 feet

You are hereby granted permission to convert geothermal well KS-1A to an injection well. Conversion of KS-1A from a production well to an injection well is contingent upon successful completion of a Testing and Injection Program as specified in the Underground Injection Permit No. 1529 and the following conditions:

(1) All work shall be performed in accordance with the permission and terms of the occupiers of the land, the Drilling and Completion Program submitted with your application, the Department's Administrative Rules (Chapters 13-183 and 13-184, HAR), and all other applicable Federal, State, and County laws, ordinances, rules, and regulations;

(2) The permittee, its successors and assigns shall indemnify, defend, and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for

property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit;

(3) The permittee shall observe and comply with all valid requirements of County, State, and Federal authorities and regulations pertaining to the lands and permittee's operations including, but not limited to, all water and air pollution control laws and those relating to the environment;

(4) The well and bottom-hole location shall be located more than 100 feet from the outer boundary of the parcel of land on which the well is situated, or more than 100 feet from a public road, street, or highway dedicated prior to the commencement of drilling, unless modified by the Chairperson upon request;

(5) The permittee shall notify the Division of Water Resource Management (DWRM), in writing, of the date of the start of the well modification/completion work;

(6) All blow-out prevention equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes. The results of the pressure tests shall be reported on forms provided by the Department.

If a drop of more than ten percent of the casing test pressure is recorded, the operator shall then run a caliper log and/or other appropriate well test to determine if the casing is defective and if corrective measures will be required before commencing any further operations. The results of the prescribed casing tests and any remedial work conducted shall be submitted to the Department within sixty days after completion;

(7) Class "G" cement shall be used in any casing cementing operations and shall contain a high temperature resistant admix;

(8) If changes to the proposed well completion program are contemplated, the permittee shall obtain the Chairperson's approval before executing such changes;

(9) Approval by the Department of Health must be received prior to commencement of injection operations proposed within the KS-1A Testing and Injection Program;

(10) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is plugged and abandoned in accordance with the Department's Administrative Rules, Chapter 13-183, HAR;

(11) The permittee shall submit to the Chairperson, the results of any exploration, all drilling and testing records, down-hole surveys of the well, bottom-hole location, date of completion, and a survey of the well location and elevation above mean sea level taken by a Hawaii licensed surveyor within six months after completion of the well;

(12) A well completion report, an as-built drawing of the well, and the location of the well plotted on an U.S.G.S. quad scale map shall be filed with the Department within six months after completion of the well conversion;

(13) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to its original condition; and

(14) This permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Department of Land and Natural Resources

FEB 1 3 1992

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
DBEDT
Department of Health
OEQC

WRM
WA-DH

PGV KS 1-A

265

Lorraine R. Inouye
Mayor

Norman K. Hayashi
Director

Tad Nagasako
Deputy Director

RECEIVED

**Planning Department**

25 Aupuni Street, Room 109 • Hilo, Hawaii 96720 • (808) 961-8288

91 SEP 25 A10:45

HAND DELIVERED

DIV. OF WATER & LAND DEVELOPMENT

September 20, 1991

Mr. Maurice A. Richard
Vice President
Puna Geothermal Venture
101 Aupuni Street, Suite 1014B
Hilo, HI 96720

Dear Mr. Richard:

Geothermal Resource Permit No. 2
Puna Geothermal Venture (PGV)

We have been informed by the Department of Land and Natural Resources (DLNR) that well head pressures at KS1-A have been increasing. The DLNR recommends that from a public safety perspective, it would be better to reduce or eliminate any pressures in the well. It is our understanding that the DLNR has already reviewed your planned operation and has granted conditional approval.

Although we have suspended "all further activities at the PGV site exclusive of efforts to fully control KS-8," the DLNR's recommendation to take immediate action to reduce or eliminate any well head pressures on KS1-A must be implemented. In that light, we are granting you the approval to perform the necessary activities to reduce or eliminate any well head pressures on KS1-A. These activities may commence on September 23, 1991, at the earliest. Other notice requirements outlined in the DLNR's approval must also be observed.

Should you have any questions, please feel free to call me.

Sincerely,

NORMAN K. HAYASHI
Planning Director

RKN/NKH:smo
3106D

cc: Mayor
Planning Commission
Managing Director
Civil Defense
Corporation Counsel
DLNR
DOH
DBEDT

J WAIHEE
NOR OF HAWAII

STATE OF HAWAII
RTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIA
BOARD OF L

KEITH W.
MANABU TAGO
DAN T. KOCHI

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CONSERVATION AND
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CONVEYANCES
FORESTRY AND WILDLIFE
HISTORIC PRESERVATION
PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

September 18, 1991

Mr. Norman Hayashi
Planning Director
Department of Planning
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Hayashi:

Puna Geothermal Venture's, KS-1A Geothermal Well

The Department of Land and Natural Resources (DLNR) requests that y office authorize Puna Geothermal Venture (PGV) to begin mitigation measu reduce well head pressures on KS-1A upon receipt of a 24-hour notice to h work from PGV.

This request is based upon DLNR's continuing monitoring and a increasing well head pressures noticed over the past two months o that it would be better to reduce or eliminate any pressures in t public safety standpoint.

Your favorable action would be appreciated.

Very t

Larry Kim, State Civil Defe
Lewin, Department of H

J. WAIHEE
[GOVER]NOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

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KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

September 18, 1991

Mr. Norman Hayashi
Planning Director
Department of Planning
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Hayashi:

Puna Geothermal Venture's, KS-1A Geothermal Well

The Department of Land and Natural Resources (DLNR) requests that your office authorize Puna Geothermal Venture (PGV) to begin mitigation measures to reduce well head pressures on KS-1A upon receipt of a 24-hour notice to begin work from PGV.

This request is based upon DLNR's continuing monitoring and assessment of increasing well head pressures noticed over the past two months on KS-1A. We feel that it would be better to reduce or eliminate any pressures in the well from the public safety standpoint.

Your favorable action would be appreciated.

Very truly yours,

WILLIAM W. PATY

cc: Mr. Harry Kim, State Civil Defense
Dr. John Lewin, Department of Health

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
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WATER RESOURCE MANAGEMENT

September 18, 1991

Mr. Norman Hayashi
Planning Director
Department of Planning
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Hayashi:

Puna Geothermal Venture's, KS-1A Geothermal Well

The Department of Land and Natural Resources (DLNR) requests that your office authorize Puna Geothermal Venture (PGV) to begin mitigation measures to reduce well head pressures on KS-1A upon receipt of a 24-hour notice to begin work from PGV.

This request is based upon DLNR's continuing monitoring and assessment of increasing well head pressures noticed over the past two months on KS-1A. We feel that it would be better to reduce or eliminate any pressures in the well from the public safety standpoint.

Your favorable action would be appreciated.

Very truly yours,

Bill Paty

WILLIAM W. PATY

cc: Mr. Harry Kim, State Civil Defense
Dr. John Lewin, Department of Health

TRANSMISSION REPORT

THIS DOCUMENT (REDUCED SAMPLE ABOVE)
WAS SENT

** COUNT **
# 1

*** SEND ***

| NO | REMOTE STATION I. D. | START TIME | DURATION | #PAGES | COMMENT |
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| | | TOTAL | 0:00'58" | 1 | |

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JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES

KEITH W. AHUE
MANABU TAGOMORI
DAN T. KOCHI

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HISTORIC PRESERVATION PROGRAM
LAND MANAGEMENT
STATE PARKS
WATER RESOURCE MANAGEMENT

September 18, 1991

Mr. William J. Teplow
Field Manager
Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Dear Mr. Teplow:

Our review of the well head pressure data for August and September, 1991 for geothermal well Kapoho State 1A (KS-1A) lead us to require immediate mitigation measures to relieve the increasing pressure for safety purposes. Hence, the Department of Land and Natural Resources orders Puna Geothermal Venture to take immediate action to reduce or eliminate any well head pressures on KS-1A.

We have reviewed your proposed well control program and approve the planned operation. If field conditions dictate modifications to your porposed program, please notify our DLNR field representative Duey Milner or Eric Tanaka and our Division of Water Resource Management in writing of these modifications.

Before you proceed with the work, we require that you give a 24-hour prior notice to the Hawaii County Planning Department, Department of Civil Defense, and the Hilo office of the Department of Health, as well as this office so that appropriate personnel would be available to monitor the work.

Additionally, you must also obtain approval from the Hawaii County Planning Department to do the work. We will recommend approval of this work to the Planning Department.

If you have any questions, please call Manabu Tagomori at 548-7533.

Sincerely,

for WILLIAM W. PATY

cc: Mr. Norman Hayashi, Planning Department
Mr. Harry Kim, State Civil Defense
Dr. John Lewin, State Department of Health

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

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CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

OCT 15 1990

REF:WRM-MH

GEOTHERMAL WELL MODIFICATION PERMIT

Kapoho State No. 1-A

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated September 14, 1990 for a permit to modify Geothermal Well Kapoho State No. 1-A is approved:

Well Designation: Kapoho State No. 1-A (KS-1A)
Location: TMK: 1-4-01:02, Kapoho, Puna, Hawaii
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VII Corporation
Ground Elevation: 620 ft. ±
Total Depth: 6,505 feet

You are hereby granted permission to modify Geothermal Well KS-1A by installing a seven-inch production liner and replacing the casing/wellhead assembly. Modification of the well shall be completed in accordance with the approved modification plans and the following conditions:

(1) All work shall be performed in compliance with the Department's Administrative Rules (Chapters 13-183 and 13-184), and all other applicable Federal, State, and County laws, ordinances, and regulations.

(2) The applicant, its successors and assigns shall indemnify and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit.

(3) The applicant shall notify the Division of Water Resource Management, in writing, of the date for the start of work.

(4) Class "G" cement shall be used in the casing cementing operations and shall contain a high temperature resistant admix.

(5) All Blow-out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes.

(6) If a drop of more than ten percent of the casing test pressure is recorded the operator shall then run a caliper log and/or other appropriate well test to evaluate if the casing is defective and if corrective measures will be required before commencing any further operations.

(7) The Department's representative shall be notified with reasonable time allowed for travel to the site to witness the required casing test. The results of the prescribed casing tests, shall be reported on forms provided by the Department and submitted for review no later than sixty days (60) after completion.

(8) A well completion report and an as-built drawing of the well shall be filed with the Department within six (6) months after completion of the well modification.

(9) The applicant shall obtain the Chairperson's approval prior to the execution of any contemplated changes in the modification program.

(10) The applicant shall submit to the Chairperson, the results of any exploration, all drilling and testing records, date of completion, and a survey of the well location and elevation by a Hawaii licensed surveyor within six months after completion of the well modification.

(11) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is properly plugged and abandoned in accordance with Chapter 13-183, HAR.

(12) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to the original condition after operations are completed.

(13) The permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

OCT 15 1990

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
Dept. of Business & Economic Development
Department of Health
Office of Environmental Quality Control

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90 SEP 18 A8:39

DIV. OF WATER &
LAND DEVELOPMENT

ORMAT®

September 14, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Request for Modification of Geothermal Production Well KS-1A, Puna Geothermal Venture.

Dear Mr. Tagomori:

Puna Geothermal Venture (PGV) is proposing to modify the casing and wellhead of geothermal production well KS-1A. PGV is hereby seeking approval from your office for this Request for Modification. The purpose of the modification is to strengthen the production casing string, eliminate possible casing leaks, and repair damage to the 9-5/8" casing within the the expansion spool. This will assure good casing integrity when KS-1A is placed in service as a production well.

The proposed work will consist of running a string of 7" cemented production liner from the surface to a depth of 3540'. Also, the 13-3/8" casing head will be replaced with a 9-5/8" casing head and 7" explansion spool. This proposed work is described in detail in the attached workover program.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 HILO, HAWAII 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

*PUNA GEOTHERMAL VENTURE*

KS-1A REWORK AND WELLHEAD REPAIR

1. Move rig over well.

2. Remove top 10" valve. Install API 3000# double gate BOP and annular preventer on top of 10" master valve.

3. Run drill pipe to top of cement plug (3500') and circulate well with cold water 4 hrs or until return temperature is stable. Start pumping at 1 barrel per minute to avoid thermal shocking well casing.

4. Mix 20 cubic feet (50 Linear feet) geothermal cement (type II with 40% silica flour) and spot on top of existing plug. W.O.C. 6 hours.

5. Remove BOP, wellhead valve and 13 3/8" x 9 5/8" expansion spool. Remove 13 3/8" x 20" expansion spool. Cut off 20" casing at floor of cellar. If no cement in 30" x 20" annulus run 1" tubing to top of cement and blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

6. Cut-off 13 3/8" casing 10' below surface. Run 1" pipe in 20" x 13 3/8" annulus to top of cement. Blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

7. Cut-off 9 5/8" casing 8' below surface and dress for welding. Center 9 5/8" casing inside 13 3/8" casing. Run 1" pipe in 13 3/8" x 9 5/8" annulus to top of cement. Blow annulus dry with air. Mix geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

8. Weld API 3000# casing head on 9 5/8" casing. Assemble double gate BOP and annular preventer on casing head.

9. Pressure test casing to 500 psi and hold for 10 minutes.

10. It pressure bleeds-off, conduct injection test and spinner survey to locate source of leak.

11. Run drill pipe to leak and circulate water 4 hours. Mix 40 cubic feet geothermal cement and place opposite leak through drill pipe, pull up 2 stands and squeeze. W.O.C. 6 hrs.

12. Run in with 8 1/2" bit and drill cement.

13. Repeat pressure test. Repeat squeeze if test fails.

14. Run drill pipe to 3400 feet and blow well dry with air.

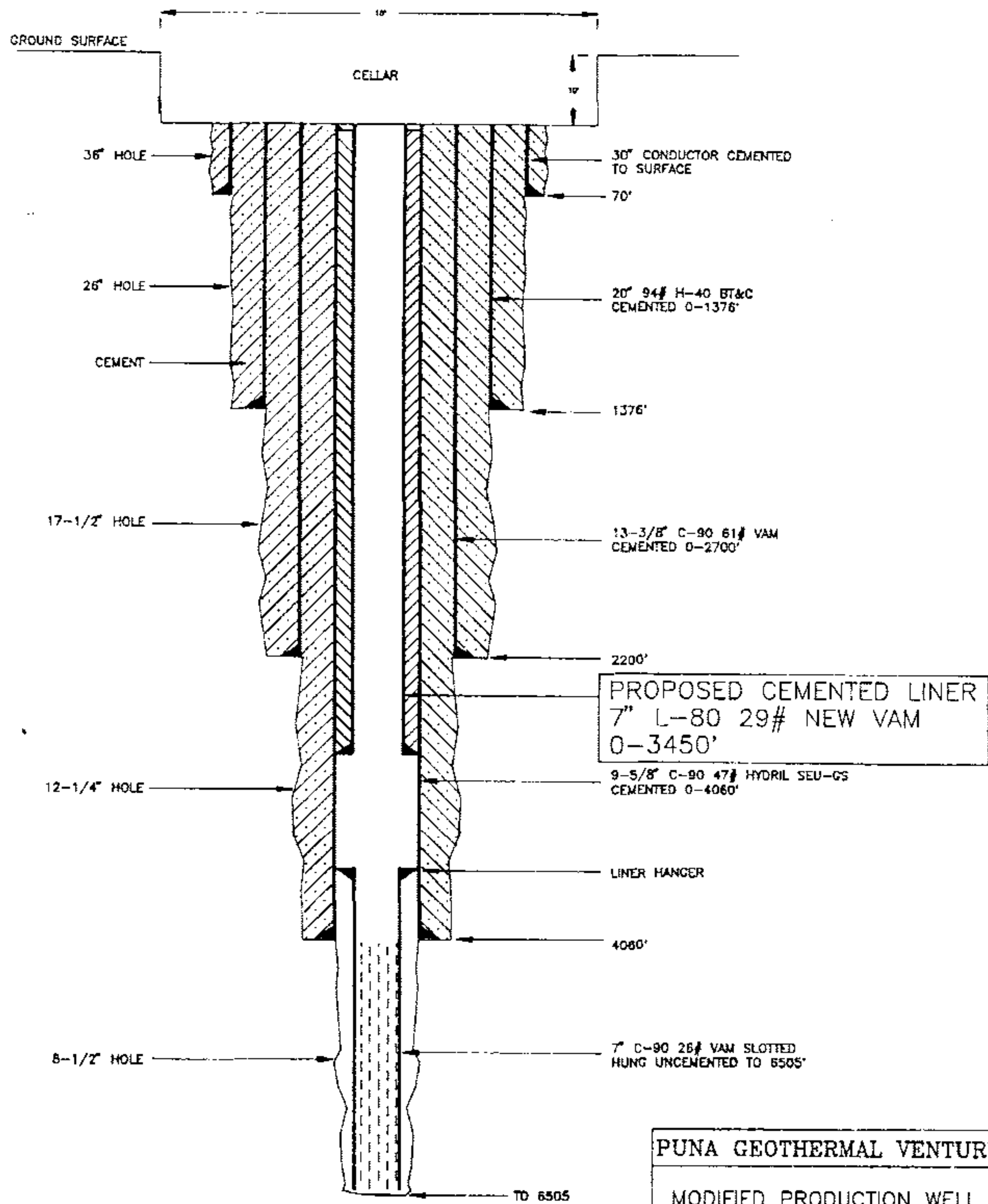
15. Run 3450 feet 7", L80, 29#, New Vam casing with centralizers on bottom three joints and 5th joint from surface. Cement to surface with 500 cubic feet geothermal cement (type II + 40% silica flour + 0.65% CFR-3). After plug is bumped unbolt and raise BOP at casing head flange. Set 7" casing alignment bowl. W.O.C. 12 hours.

16. Install API 3000# 9 5/8" x 7" expansion spool and pack-off. Install 8" ANSI 900 wellhead valve. Reassemble double gate BOP and annular preventer.

17. Run 6" bit and drill out cement plug with water. Run bit to top of 7" liner.

18. POOH laying down drill pipe. Remove BOP and install second 8" ANSI 900 wellhead valve.

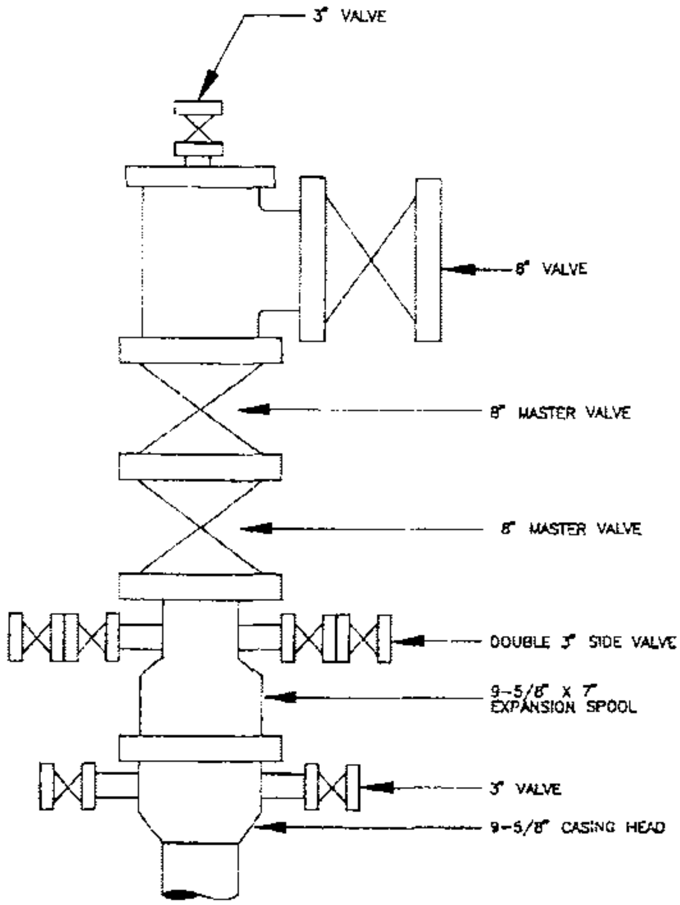
19. Allow well to warm approximately 15 days. Install flowline to storage pit and flow well approximately 30 minutes to clean.




PUNA GEOTHERMAL VENTURE

MODIFIED PRODUCTION WELL
CASING DESIGN
KS-1A

| | | |
|---|---|---|
| DATE 9/14/90 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 1 |




PUNA GEOTHERMAL VENTURE

MODIFIED WELLHEAD
CONFIGURATION
PRODUCTION WELL KS-1A

| | | |
|---|---|---|
| DATE 8/14/90 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 2 |

JOHN WAIHEE
GOVERNOR OF HAWAII

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

Mr. Maurice A. Richard
Regional Development Manager
Puna Geothermal Venture
101 Aupuni Street, Suite 1014-B
Hilo, Hawaii 96720

Dear Mr. Richard:

The Department of Land and Natural Resources requests the timely submittal of the quarterly summary report of monitoring activities for Kapoho State No. 1-A (KS-1A).

Additionally, please include the results of the KS-1A casing integrity test conducted on June 26, 1990. It is our understanding that KS-1A was filled with water and monitored for any drop in water level to test for leakage within the wellbore. A brief discussion concerning the results of this casing test and any other pertinent information is requested.

Please be advised that your next quarterly summary report should also include the results of your monitoring of the other PGV wells: Kapoho State No. 1 and 2. Additionally, please submit an as-built drawing of Kapoho State No. 1 showing the location and thicknesses of the cement plugs set within the casing.

Your prompt attention and response to the above will be greatly appreciated. Should you have any questions, please contact me at 548-7533.

Sincerely,

MANABU TAGOMORI
Deputy Director

DN:mh

FEB 2 1990

WDF:WL-KG

Mr. Maurice A. Richard
Regional Development Manager
Puna Geothermal Venture
101 Aupuni Street, Ste. 1014-B
Hilo, Hawaii 96720

Dear Mr. Richard:

This is to acknowledge the receipt of your letter dated January 8, 1990, regarding the plugging operations for geothermal well Kapoho State 1-A.

Please note that the temperature and pressure survey results referenced in your letter were not included with the other submitted information. As such, please transmit the survey results as soon as possible. Because of the proprietary nature of the data, we hold the temperature and pressure surveys confidential for a period of one year from the date of receipt.

Additionally, the Department will require the filing by PGV of quarterly summary reports on the results of its monitoring of the well such that we may ascertain the continuous safety and stability of Kapoho State 1-A.

Your attention to the above would be greatly appreciated. Should you have any questions, please contact Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

WILLIAM W. PATY

MT:DN:GSM:ko

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
COMMISSION ON WATER RESOURCE MANAGEMENT
P. O. BOX 621
HONOLULU, HAWAII 96809



REF:WL-BM

OCT 24 1989

Mr. Maurice A. Richard
Regional Development Manager
Puna Geothermal Venture
101 Aupuni Street, Suite 1014-B
Hilo, Hawaii 96720

Dear Mr. ~~Richard:~~ Maurice

The Department of Land and Natural Resources acknowledges the receipt of the Well Completion Report and as-built drawing of Geothermal Well, Kapoho State No. 1-A, as required under the Geothermal Well Modification Permit issued on June 16, 1989, for the setting of a temporary cement plug within the well casing.

Preliminary review of the Well Completion Report indicates that condition No. 3 of the Department's Geothermal Well Modification Permit, concerning the performance of a casing pressure test to evaluate the integrity of the casing string, was not complied with by the Applicant.

Your report states that a casing pressure test was not conducted during the plugging operations inorder to allow the cement plug to set to full strength, and to avoid the possiblilty of dislodging the plug within the casing.

While other measures are being proposed to monitor the possbility of a casing leak, the Department still requires the performance of a casing pressure test of Kapoho State No. 1-A, and the submittal of the recorded data as soon as possible.

Furthermore, the Chronology of Operations outlined in your report indicates that the well modification/plugging activity began on May 30, 1989, seventeen (17) days before the issuance of the Well Modification Permit by the Department. Please provide a written explanation of the discrepancy and/or rationale for such unauthorized commencement of such activity.

In addition, concurrent with our evaluation of the Well Completion Report, the Department hereby requests the timely submittal of the down-hole pressure and temperature surveys conducted during the course of the plugging operations for Kapoho State No. 1-A.

Your prompt attention and response to the above will be greatly appreciated. Should you have any questions, please contact Manabu Tagomori, Deputy Director, at 548-7533.

Very truly yours,

Bill

William W. Paty

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

# GEOTHERMAL WELL MODIFICATION PERMIT

Kapoho State 1-A
Puna, Hawaii

TO: Puna Geothermal Venture
101 Aupuni Street, Suite 1014-B
Hilo, Hawaii 96720

Your application dated May 22, 1989, for a permit to modify Geothermal Well Kapoho State 1-A, is approved:

Well Designation: Kapoho State 1-A
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii
Mining Rights: Kapoho Land Partnership, under State Geothermal Resource Mining Lease R-2
Subleased to: Puna Geothermal Venture
Operator: ORMAT/AMOR VIII Corporation
Ground Elevation: 619 ft.
Total Depth: 6,505 feet

You are hereby granted permission to modify Geothermal Well Kapoho State 1-A by installing a temporary cement plug in the wellbore casing. Modification of the well shall be completed in accordance with the following conditions:

(1) The 150-foot cement plug shall be set in the 9-5/8" casing from a depth of 3,800 feet to 3,650 feet. A sinker bar shall be run into the casing to the top of the cement plug to verify the depth of the cement.

(2) Class "G" cement shall be used in the plugging operations and shall contain a high temperature resistant admix.

(3) After it has been verified that the cement plug has been set to the approved depth and thickness, the operator shall conduct a casing pressure test to evaluate the integrity of the casing string. Minimum casing test pressure shall be approximately one-third of the manufacturer's rated internal yield pressure and shall be applied for a period of thirty minutes.

(4) If a drop of more than ten percent of the casing test pressure is recorded, the operator shall then run a caliper log and/or other appropriate well test to evaluate if the casing is defective and if corrective measures will be required before commencing any further operations.

(5) A well completion report and an as-built drawing of the well modification shall be filed with the Department within six months after completion of the well modification.

(6) A well test report showing the results of the prescribed casing tests conducted, shall be submitted to the Department for review within sixty days after completion.

(7) The applicant shall obtain the Chairperson's approval prior to the execution of any contemplated changes in the modification program.

(8) All work shall be performed in compliance with the Department's Administrative Rules (Chapter 13-183), and all other applicable Federal, State, and County laws, ordinances, rules and regulations.

(9) The applicant, its successors and assigns, shall indemnify and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit.

(10) The applicant shall notify the Division of Water and Land Development, in writing, of the date of the start of work.

(11) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface properly restored.

(12) This permit shall expire 365 days from the date of issuance.

for

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

6.12.89
Date of Issuance

WL

c- Sono

681

ORMAT®

May 22, 1989
Reference No. 89141

Mr. William Paty
Chairman
Board of Land and Natural Resources
Kalanimoku Building, #130
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Well Modification Permit Request

Reference: Geothermal Well: Kapoho State #1-A
Geothermal Resources Mining Lease R-2
Location TMK 1-4-01:02 Kapoho, Puna District,
Hawaii County Leased to Kapoho Land Partnership

Dear Mr. Chairman:

A Department of Land and Natural Resources (DLNR) permit exists for the drilling and completion of the reference well. Since the conclusion of drilling and flow testing in 1985, Kapoho State #1-A has been maintained in a shut-in status with periodical gas cap ventings and incineration or burning of the exhausted gases. Puna Geothermal Venture (PGV) has closely monitored this well and complied with DLNR reporting requirements.

Puna Geothermal Venture herewith submits a Well Modification Permit request consistent with Chapter 183 of Title 13, Subchapter 183-65-4.

The attached work description and well casing configuration drawing including the approximate location of the proposed cement plug is attached for reference.

In brief, the PGV request is based on a technical need to periodically service the wellhead assembly to maintain a high standard of reliability and integrity. This routine servicing process is also timed to fit within the overall 30 MW development schedule and expected County permitting approvals and related requirements now in progress.

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
☐ 610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125

Your early consideration and approval will be appreciated. Please contact the Hilo office of Puna Geothermal Venture if you or your staff have any questions about the above request.

Sincerely,

Maurice A. Richard
Hawaii Region
Development Manager

Attachment

MAR/ci

11 May 1989

Program to Temporarily Suspend KS-1A with Cement Plug

1) Purpose of Work

It will be at least a minimum of a year before KS-1A is needed for production service. Therefore PGV has decided to temporarily suspend the well by setting a 150 foot cement plug in the casing at 3000 feet. This will eliminate the need for further gas burns and will permit the wellhead to be serviced and the condition of the production casing to be checked in preparation for putting the well in service.

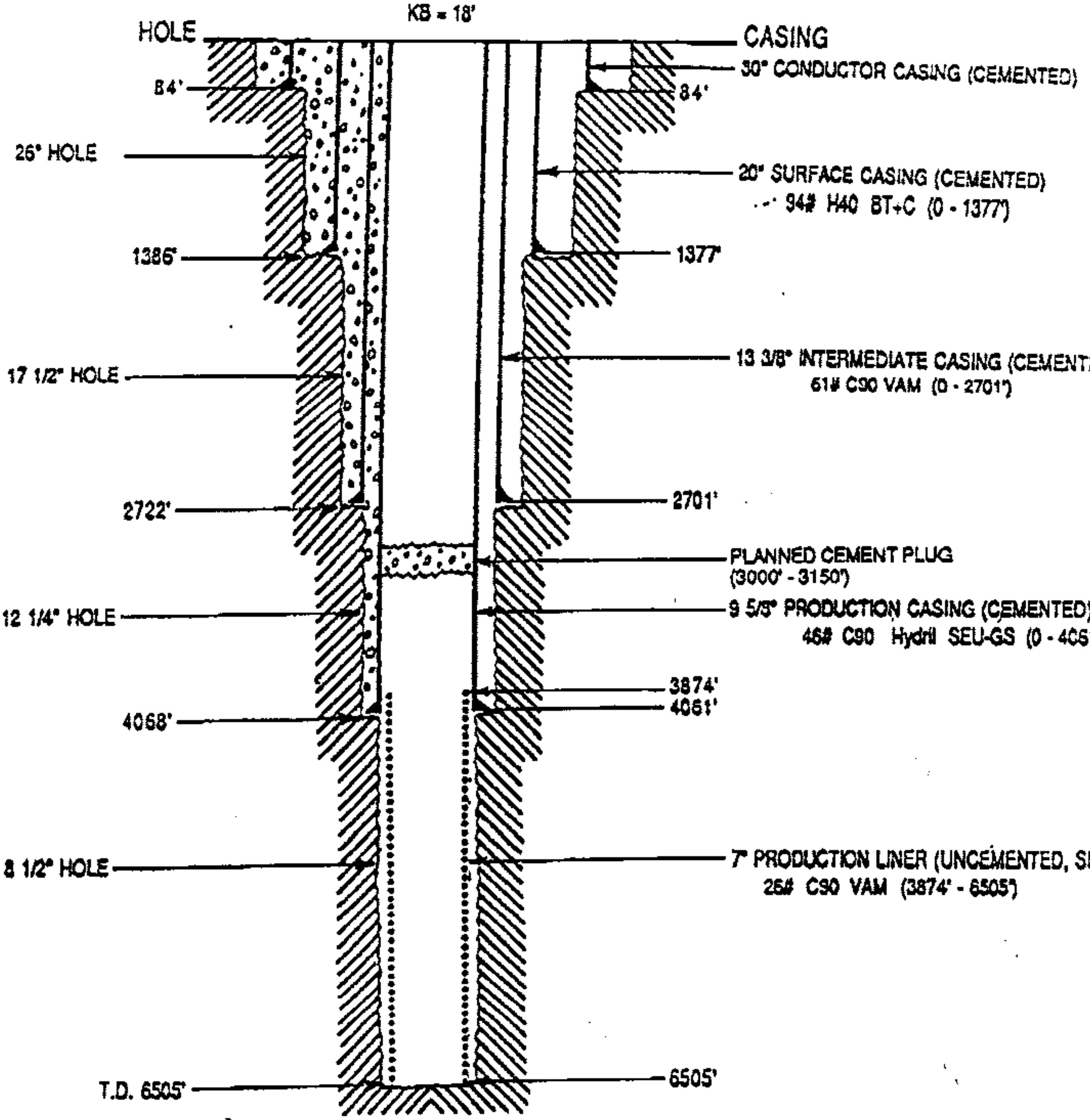
2) Plan of Work

The design of KS-1A showing the planned cement plug is shown in the attached figure. The setting depth of 3000 feet was chosen in order that the reservoir pressure beneath the plug will be balanced by the pressure exerted by the column of water in the wellbore above the plug. A rig will not be needed to carry out the work.
The operation is planned as follows :

1. Run sinker bar to 4500 feet.
2. Run a static pressure and temperature survey to 4500 feet.
3. Nipple-up pump to 3" side valve and kill well by slowly pumping cold water.
4. With the well killed run an 8" gauge ring to 3500 feet. Continue to pump water to maintain kill.
5. Run temperature survey to 4000 feet while maintaining kill to assess wellbore temperatures for cement slurry design.
6. Insert 9 5/8" bottom wiper plug through wellhead.
7. Pump 75 gallons (25 liner feet) water on top of plug.
8. Mix 60 cu ft (150 liner feet) geothermal cement and drop on top of water.
9. Insert top wiper plug and displace cement plug to 3000 feet with water (220 barrels).
10. Wait on cement 24 hours.
11. Run sinker bar to top of cement to check depth.
12. Shut-in wellhead and secure.

The operation is anticipated to take a total of 5 to 7 days.

KAPOHO STATE #1A WELL




Planned Cement Plug in KS-1A

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

LIBERT K. LANDGRAF
DEPUTY

COPY

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

# GEOTHERMAL WELL MODIFICATION PERMIT

Kapoho State 1-A
Puna, Hawaii

TO: Thermal Power Co.
220 South King Street, Suite 1750
Honolulu, Hawaii 96813

Your application dated January 27, 1988, for a permit to modify Geothermal Well Kapoho State 1-A, is approved:

Well Designation: Kapoho State 1-A
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii
Mining Rights: Kapoho Land Partnership, under State Mining Lease R-2
Subleased to: Thermal-Amfac Joint Venture
Operator: Thermal Power Co. (for Puna Geothermal Venture)
Ground Elevation: 619 feet
Total Depth: 6,505 feet

Your are hereby granted permission to modify Geothermal Well Kapoho State 1-A by installing a temporary cement plug in the wellbore casing from a depth of approximately 3,000 feet to 2,750 feet, and by filling the casing above the plug with a corrosion-inhibiting fluid mixture. Modification of the well shall be in accordance with the following conditions:

(1) All work shall be performed as described in the proposed modification program submitted with your application and in accordance with the Department's Administrative Rules (Chapter 183), and all other applicable Federal, State, and County laws, ordinances, rules and regulations.

(2) The applicant shall obtain the Chairperson's approval prior to the execution of any contemplated changes in the proposed modification program.

(3) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface properly restored.

(4) This permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

MAR 1 1[illegible]

Date of Issuance

JAN

Mr. Ralph A. Patterson, Jr.
Hawaii Project Manager
Thermal Power Company
1600 Kapiolani Blvd., Suite 808
Honolulu, Hawaii 96814

Dear Mr. Patterson:

Geothermal Drilling Permit-Kapoho State No. 1-A

The Department of Land and Natural Resources approves your request, dated December 19, 1984, for a 180-day extension of the drilling permit for Kapoho State No. 1-A. The new expiration date is September 24, 1985.

Please be informed that all provisions of the original permit are applicable through this extension period and that reasonable prior notice should be given our staff whenever any testing is to be conducted. Appropriate lead time is necessary for scheduling staff personnel to inspect the test activities.

Additionally, the following conditions are applicable to this permit:

- The applicant shall comply with all valid requirements of all municipal, state and federal authorities and observe all municipal, state and federal laws and regulations pertaining to the lands and permittee's operations, which are now in force or which may hereafter be in force, including, but not limited to, all water and air pollution control laws, and those relating to the environment. The State of Hawaii, acting in its governmental capacity, may by regulation regulate the drilling, location, spacing, testing, completion, production, operation, maintenance and abandonment of a well or wells or similar activity as well as the construction, operation and maintenance of any other facilities in the exercise of its police powers to protect the public health, welfare and safety as provided in the regulations.

o Pollution of the ocean and tidelands, rivers, or other bodies of water, and all impairment of and interference with bathing, fishing, or navigation in the waters of the ocean or any bay or inlet thereof is prohibited, and no brine, minerals, or any refuse of any kind from any well or works shall be permitted to be deposited on or pass into waters of the ocean, any bay or inlet thereof, rivers, lakes or other bodies of water, without specific written State authorization.

o No substances which may be produced from any well drilled upon the lands shall be blown, flowed, or allowed to escape into the open air or on the ground in such a manner as to create a nuisance, which shall specifically include but not be limited to noise, air or other pollution, and other activities which disturb the occupier's or his tenant's use of the lands. Subject to the foregoing, the applicant may bleed substances to the atmosphere so long as such operations are lawfully and prudently conducted in accordance with good geothermal drilling and production practices and are not otherwise in violation of the law.

Very truly yours,

SUSUMU ONO
Chairperson of the Board

MT:DN:ko

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

DIVISIONS:
AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

GEOTHERMAL WELL DRILLING PERMIT
Kapoho State 1-A

TO: Thermal Power Company
601 California Street
San Francisco, California 94108

Your application, dated January 30, 1984, for a permit to drill a geothermal well as follows, on lands included in State of Hawaii, Department of Land and Natural Resources, Geothermal Resources Mining Lease No. R-2, is approved:

Well Designation: Kapoho State 1-A
Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii
Leased To: Kapoho Land Partnership
Subleased To: Thermal-Dillingham-Amfac Joint Venture
Operator: Thermal Power Co.
Ground Elevation: 600 ft. ±
Total Depth: 7,500 feet

You are hereby granted permission to drill the geothermal well described above and in your application in accordance with the Department's Administrative Rules, Chapter 183 of Title 13, and the following conditions:

(1) All work shall be performed in accordance with the Drilling and Completion Procedures submitted with your application, the Department's Administrative Rules (Chapter 183), and all other applicable Federal, State, and County laws, ordinances, rules and regulations.

(2) Item 3 of your submitted Drilling and Completion Procedures shall be performed after drilling has reached the depth of 630 feet ± (30 feet below sea level) and the Department's representative shall be notified, with reasonable time allowed for travel to the site, to measure and/or verify the measurement of the static water level.

(3) If there are any contemplated changes in the proposed drilling program, the operator shall obtain the Chairperson's approval prior to the execution of any such contemplated changes of work.

SUSUMU ONO, Chairperson
Board of Land & Natural Resources

3/28/84
Date of Permit

bcc: Board Members
Land Management Div.
Planning Office
Hawaii Planning Dept.
OEQC
DPED
Health Dept

Kleen

OCT 16 1985

Mr. Ralph A. Patterson, Jr.
Hawaii Project Manager
Thermal Power Company
~~1600 Kapiolani Blvd., Suite 808~~
~~Honolulu, Hawaii 96814~~
220 South King St., Suite 1750
Honolulu, HI 96813

Dear Mr. Patterson:

The Department of Land and Natural Resources has reviewed the matter of record submittal and the confidentiality provision of our rules pertaining to the use of all physical and factual exploration results, logs, surveys and other data resulting from geothermal operations.

Pursuant to section 13-183-62, Chapter 183, Administrative Rules, such "information shall be kept confidential as a trade secret for a period of one year from date of receipt, or longer at the discretion of the Board." The reports for Kapoho State 1 and Kapoho State 2 have been kept confidential by DLNR since the date of receipt on December 11, 1981 and August 16, 1982, respectively. The Department of Land and Natural Resources will henceforth make this information part of our public record and will be available for use by individuals upon written request to the Department.

We look forward to continued cooperation with Thermal Power Company on the matter of records and reports in the best interest of the State and other concerned parties. If you should have any questions, please contact Mr. Manabu Tagomori of the Division of Water and Land Development at 548-7533.

Very truly yours,

SUSUMU ONO
Chairperson of the Board

MT:DN:ey

OCT 16 1985

Mr. E.C. Craddick, President
Barnwell Geothermal Corp.
2828 Paa Street, Suite 2085
Honolulu, Hawaii 96819

Dear Mr. Craddick:

The Department of Land and Natural Resources has reviewed the matter of record submittal and the confidentiality provision of our rules pertaining to the use of all physical and factual exploration results, logs, surveys and other data resulting from geothermal operations.

Pursuant to section 13-183-62, Chapter 183, Administrative Rules, such "information shall be kept confidential as a trade secret for a period of one year from date of receipt, or longer at the discretion of the Board." The reports for Lanipuna Well #1, Lanipuna Well #1/Sidetrack and Ashida Well #1 have been kept confidential by DLNR since the date of receipt on April 16, 1984. The Department of Land and Natural Resources will henceforth make this information part of our public record and will be available for use by individuals upon written request to the Department.

We look forward to continued cooperation with Barnwell Geothermal Corporation on the matter of records and reports in the best interest of the State and other concerned parties. If you should have any questions, please contact Mr. Manabu Tagomori of the Division of Water and Land Development at 548-7533.

Very truly yours,

SUSUMU ONO
Chairperson of the Board

MT:DN:ey

WATEI :ESOURCES & FLOOD CONTROI RANCH
Division of Water and Land Development

FROM: Dean DATE: 2/10/82 FILE IN:

TO: INITIAL:

- T. FUJII
- D. Lum
- E. Sakoda
- D. Nakano
- J. Menor
- M. Ohye
- S. Samuels
- W. Koyanagi
- D. Hamada
- K. Oshiro
- ✓ M. Tagomori
- H. Sakai
- H. Morimatsu
- J. Sato

PLEASE:

- See Me
- Call
- Review & Comment
- Take Action
- Investigate & Report
- Draft Reply
- Acknowledge Receipt
- Type Draft
- Type Final cc:
- Xerox copies
- File
- Mail

FOR YOUR:

- ✓ Approval
- Signature
- Information

REMARKS:

Manabu,

Per your instructions, attached are the letters concerning the release of confidential info for Thermal Power & Barnwell.

One suggestion may be to require that any party that wants this data, must come to DLWD for the release of info. This would apply to Hawaii County also, whereby they would be restricted from distributing the data that we send to them.

Dean

# PUNA GEOTHERMAL VENTURE
*A Hawaii Partnership*

OCT 15 11 52 AM '93

October 14, 1993

Keith W. Ahue, Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

RECEIVED
93 OCT 21 A10:17
DIV. OF WATER & LAND DEVELOPMENT

SUBJ: UIC INJECTION WELL PRESSURE TESTING

Dear Mr. Ahue,

Puna Geothermal Venture (PGV) would like to notify you that we will be performing the required casing pressure testing of injection wells KS-3 and KS-1A beginning this coming Tuesday morning, October 19, 1993.

I have enclosed our notifications to the DOH for your information. Should you or your staff have any questions, please contact myself or PGV Wellfield Superintendent Greg Davidson.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

c: S. Morris
D. Berube
G. Davidson
M. Tagomori (DLNR)

File: UIC

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

# PUNA GEOTHERMAL VENTURE

*A Hawaii Partnership*

October 14, 1993

John C. Lewin, M.D., Director
State Department of Health
P.O. Box 3378
Honolulu, HI 96801

SUBJ: INJECTION WELL PRESSURE TESTING

Dear Dr. Lewin,

Puna Geothermal Venture (PGV) would like to inform you that we will be commencing casing pressure testing of injection wells KS-3 and KS-1A as required under our Underground Injection Control Permit on (UIC) Tuesday, October 19, 1993 at approximately 7:00 am.

As per Special Condition No. 8 of Permit To Operate (PTO) No. P-833-1399, we wish to request permission to release nitrogen gas used in pressure testing operations. Approximately 300,000 standard cubic feet will be utilized in each well to accomplish testing objectives. This gas must be released after operations are complete in order to commence reinjection of fluids. Should any hydrogen sulfide be encountered near the end of the nitrogen, the well will be shut-in and the remaining nitrogen will be forced down the hole with make-up water or injectate.

Should you or your staff have any questions, please contact myself or Greg Davidson, our Wellfield Superintendent who will be supervising the testing.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

c: S. Morris
D. Berube
G. Davidson
N. Hirai (DOH)

File: UIC

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

# PUNA GEOTHERMAL VENTURE

*A Hawaii Partnership*

October 14, 1993

Mr. Chauncey Hew
Safe Drinking Water Branch
State Department of Health
P.O. Box 3378
Honolulu< HI 96801

SUBJ: UIC INJECTION WELL PRESSURE TESTING

Dear Chauncey,

Puna Geothermal Venture (PGV) would like to inform you that we will be commencing injection well casing pressure testing on Wells KS-3 and KS-1A as required by our Underground Injection Control Permit (UIC) on Tuesday, October 19, 1993 at approximately 7:00 am. We will begin with KS-3. Testing is expected to be completed on Wednesday, October 20.

Please contact me if you have any questions.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

c: D. Berube
   G. Davidson

File: UIC

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

ISION OF WATER AND LAND DEVELOP NT

FROM: ______ DATE: 10 / ______ FILE IN: ______

| TO: | INIT: | | PLEASE: | | REMARKS: |
|---|---|---|---|---|---|
| | | M. TAGOMORI | | See Me | Hard Copy |
| ✓ | | L. Nanbu | | Call | |
| | | ~~G. Akita~~ | | Review & Comment | |
| | | L. Chang | | Take Action | |
| | | E. Lau | | Investigate & Report | |
| ✓ | | A. Monden | | Draft Reply | |
| | | H. Young | | Acknowledge Receipt | |
| | | T. Kam | | Type Draft | |
| | | G. Miyashiro | | Type Final | |
| | | D. Lee | | Xerox ____ copies | |
| | | A. Yim | | File | |
| | | ~~gg~~ Hirata | | | |
| | | (Chris/File) | | | |

FOR YOUR:

| | | | | |
|---|---|---|---|---|
| | | R. LOUI | | Approval |
| | | S. Kokubun | | Signature |
| | | | | Information |

WATER QUALITY DATA

| DATE | TEMPER-ATURE (DEG C) (00010) | NITRO-GEN, NO2+NO3 DIS-SOLVED (MG/L AS N) (00631) | CALCIUM DIS-SOLVED (MG/L AS CA) (00915) | MAGNE-SIUM, DIS-SOLVED (MG/L AS MG) (00925) | SODIUM, DIS-SOLVED (MG/L AS NA) (00930) | POTAS-SIUM, DIS-SOLVED (MG/L AS K) (00935) | FLUO-RIDE, DIS-SOLVED (MG/L AS F) (00950) | SILICA, DIS-SOLVED (MG/L AS SIO2) (00955) | ARSENIC TOTAL (UG/L AS AS) (01002) | BARIUM, TOTAL RECOV-ERABLE (UG/L AS BA) (01007) |
|---|---|---|---|---|---|---|---|---|---|---|
| JUL , 1985 | | | | | | | | | | |
| 20... | 43.5 | .45 | 39 | 7.9 | 260 | 42 | .40 | 9.5 | 4 | 300 |

| DATE | BERYL-LIUM, TOTAL RECOV-ERABLE (UG/L AS BE) (01012) | CADMIUM TOTAL RECOV-ERABLE (UG/L AS CD) (01027) | CHRO-MIUM, TOTAL RECOV-ERABLE (UG/L AS CR) (01034) | COBALT, TOTAL RECOV-ERABLE (UG/L AS CO) (01037) | COPPER, TOTAL RECOV-ERABLE (UG/L AS CU) (01042) | IRON, TOTAL RECOV-ERABLE (UG/L AS FE) (01045) | IRON, DIS-SOLVED (UG/L AS FE) (01046) | LEAD, TOTAL RECOV-ERABLE (UG/L AS PB) (01051) | MANGA-NESE, TOTAL RECOV-ERABLE (UG/L AS MN) (01055) | MANGA-NESE, DIS-SOLVED (UG/L AS MN) (01056) |
|---|---|---|---|---|---|---|---|---|---|---|
| JUL , 1985 | | | | | | | | | | |
| 20... | <1 | <1 | 10 | 1 | 4 | 140 | 20 | 3 | 10 | <10 |

| DATE | MOLYB-DENUM, TOTAL RECOV-ERABLE (UG/L AS MO) (01062) | NICKEL, TOTAL RECOV-ERABLE (UG/L AS NI) (01067) | SILVER, TOTAL RECOV-ERABLE (UG/L AS AG) (01077) | ZINC, TOTAL RECOV-ERABLE (UG/L AS ZN) (01092) | ALUM-INUM, TOTAL RECOV-ERABLE (UG/L AS AL) (01105) | LITHIUM TOTAL RECOV-ERABLE (UG/L AS LI) (01132) | SELE-NIUM, TOTAL (UG/L AS SE) (01147) | MERCURY TOTAL RECOV-ERABLE (UG/L AS HG) (71900) | ALKA-LINITY LAB (MG/L AS CACO3) (90410) |
|---|---|---|---|---|---|---|---|---|---|
| JUL , 1985 | | | | | | | | | |
| 20... | 13 | 1 | <1 | 30 | 990 | 90 | 2 | <.1 | 71 |

# PUNA GEOTHERMAL VENTURE
*A Hawaii Partnership*

93 APR 13 P2:22

93 APR 8 A9:39

April 7, 1993

Keith Ahue, Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

SUBJ: PRODUCTION AND INJECTION REPORTS FOR MARCH,1993

Dear Mr. Ahue,

Pursuant to DLNR Regulations 18-183-86, Puna Geothermal Venture hereby submits the required monthly production and injection report.

Should you or your staff have any questions, please contact me.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

c: S. Morris
Drilling
E. Tanaka

File: UIC

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

KS-1A INJECTION WELL DATA

| Date | Hours On Inj. | Quantities of Fluid Injected (M pounds) Geofluid | Supp Wtr | Other Code | Other Quantity | Total | Average Inj Rate (M lb/hr) | Wellhead Press, psig Avg. | Wellhead Press, psig Max. | Average Annulus N2 Press (psig) | Average Inj Temp (Deg F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 03/01/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/02/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/03/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/04/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/05/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/06/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/07/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1260 | |
| 03/08/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 10 | 10 | 1260 | |
| 03/09/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 10 | 10 | 1260 | |
| 03/10/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 10 | 10 | 1080 | |
| 03/11/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 10 | 10 | 1065 | |
| 03/12/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 20 | 20 | 1050 | |
| 03/13/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 20 | 20 | 1050 | |
| 03/14/93 | 24 | 0 | 240 | | 0 | 240 | 10 | 20 | 20 | 1050 | 75 |
| 03/15/93 | 24 | 0 | 360 | | 0 | 360 | 15 | 10 | 10 | 1050 | 75 |
| 03/16/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1140 | |
| 03/17/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1155 | |
| 03/18/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1170 | |
| 03/19/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1170 | |
| 03/20/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1170 | |
| 03/21/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1170 | |
| 03/22/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1185 | |
| 03/23/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1200 | |
| 03/24/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1215 | |
| 03/25/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1245 | |
| 03/26/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1245 | |
| 03/27/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1245 | |
| 03/28/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1245 | |
| 03/29/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1065 | |
| 03/30/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1050 | |
| 03/31/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1125 | |
| Mo. Total | 48 | 0 | 600 | | 0 | 600 | | | | | |

PUNA GEOTHERMAL VENTURE
KS-1A INJECTION WELL DATA

| Date | Hours On Inj. | Quantities of Fluid Injected (M pounds): Geofluid | Supp Wtr | Other: Code | Other: Quantity | Total | Average Inj Rate (M lb/hr) | Wellhead Press, psig: Avg. | Wellhead Press, psig: Max. | Average Annulus N2 Press (psig) | Average Inj Temp (Deg F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/01/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/02/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/03/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/04/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/05/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/06/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/07/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/08/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/09/92 | 1 | 0 | 83 | | 0 | 83 | 83 | 0 | 0 | 1220 | 101 |
| 12/10/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/11/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/12/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/13/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/14/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/15/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/16/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/17/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/18/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/19/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/20/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 12/21/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/22/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/23/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/24/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/25/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/26/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/27/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/28/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/29/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/30/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 12/31/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| Mo. Total | 1 | 0 | 83 | | 0 | 83 | | | | | |

PUNA GEOTHERMAL VENTURE
KS-3 INJECTION WELL DATA

| Date | Hours On Inj. | Quantities of Fluid Injected (M pounds) Geofluid | Supp Wtr | Other Code | Other Quantity | Total | Average Inj Rate (M lb/hr) | Wellhead Press, psig Avg. | Wellhead Press, psig Max. | Average Annulus N2 Press (psig) | Average Inj Temp (Deg F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/01/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1060 | |
| 12/02/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1040 | |
| 12/03/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1040 | |
| 12/04/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1020 | |
| 12/05/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1020 | |
| 12/06/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/07/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/08/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/09/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/10/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/11/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1000 | |
| 12/12/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 980 | |
| 12/13/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 980 | |
| 12/14/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 980 | |
| 12/15/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 960 | |
| 12/16/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 960 | |
| 12/17/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 960 | |
| 12/18/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 940 | |
| 12/19/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 940 | |
| 12/20/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 940 | |
| 12/21/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 920 | |
| 12/22/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 920 | |
| 12/23/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/24/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/25/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/26/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/27/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/28/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/29/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/30/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/31/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| Mo. Total | 0 | 0 | 0 | | 0 | 0 | | | | | |

PUNA GEOTHERMAL VENTURE
KS-4 INJECTION WELL DATA

| Date | Hours On Inj. | Quantities of Fluid Injected (M pounds): Geofluid | Supp Wtr | Other: Code | Other: Quantity | Total | Average Inj Rate (M lb/hr) | Wellhead Press, psig: Avg. | Wellhead Press, psig: Max. | Average Annulus N2 Press (psig) | Average Inj Temp (Deg F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 12/01/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/02/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/03/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/04/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/05/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/06/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/07/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 12/08/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 952 | |
| 12/09/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 945 | |
| 12/10/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 935 | |
| 12/11/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 920 | |
| 12/12/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 915 | |
| 12/13/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 910 | |
| 12/14/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 905 | |
| 12/15/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 900 | |
| 12/16/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 895 | |
| 12/17/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 890 | |
| 12/18/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 880 | |
| 12/19/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 875 | |
| 12/20/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 870 | |
| 12/21/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 865 | |
| 12/22/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 860 | |
| 12/23/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 855 | |
| 12/24/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 850 | |
| 12/25/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/26/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/27/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/28/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/29/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/30/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| 12/31/92 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 840 | |
| Mo. Total | 0 | 0 | 0 | | 0 | 0 | | | | | |

**PUNA GEOTHERMAL VENTURE**

*A Hawaii Partnership*

March 18, 1993

Keith W. Ahue, Chairperson
Department of Land and Natutal Resources
P.O. Box 621
Honolulu, HI 96809

SUBJ: WORKOVER RECORDS FOR KS-1A AND KS-3

Dear Mr. Ahue,

Puna Geothermal Venture hereby submits the workover records for Well Kapoho State 1A (KS-1A) and Kapoho State 3 (KS-3). Should you or your staff have any questions, please contact me.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

c: S. Morris
Drilling

File: KS-1A/KS-3

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

# PGV
# WORKOVER RECORD

...POHO LAND PARTNERSHIP START DATE 10/28/92 COMP DATE 10/29/92
KAPOHO STATE NO. 1A CONTRACTOR CRANE
PUNA RIG # N/A
...ATION 8902.9' N & 9919.0' E ELEVATION: GROUND 618'
OF THE KALIU BENCHMARK K.B. TO GROUND N/A
KANAINA KAPOHO, PUNA K.B. TO CSG. HEAD N/A
DISTRICT, HAWAII COUNTY, HAWAII

B.H.L.
TYPE WELL: EXPL. DEV. XX OBSV STM INJ XX
DEPTH: TD TVD ETD HOT WTR DRY HOLE
COMPANY SUPERVISOR D. WEISGERBER

APPROVED B. RICKARD/P.STROUD

## CASING RECORD

| SIZE | WEIGHT | GRADE | THREAD | TOP | BOTTOM | REMARKS |
|---|---|---|---|---|---|---|
| | | | | | | |
| | | | | | | |
| | | | | | | |
| | | | | | | |
| 5" | 23.2# | L-80 | NEW VAM | SURF | 3743' | HUNG W/FOSTER DONU... |

## WELL HEAD ASSEMBLY

| | CASING HEAD | EXPANSION SPOOL | HANGER SPOOL | XO SPOO... |
|---|---|---|---|---|
| MAKE: | WKM | WKM | FOSTER | |
| TYPE: | SOW | FLANGED W/RING | DBL STD | |
| SERIAL # | N/A | 44692 | N02818 | |
| DESCRIPT | 2 SIDE OUTLETS | 2 SIDE OUTLETS | DONUT | |
| SIZE | 9⅝"X9"-3M | 7"X9"-3M | 9"-3M | |
| I.D. | 9⅛ | | | |
| LENGTH | 18" | 2.70 | .68 | |
| PRESS. RATING | | | | |

10/2...

PUNA GEOTHERMAL VENTURE
KS-1A INJECTION WELL DATA

| Date | Hours On Inj. | Quantities of Fluid Injected (M pounds) | | | | | Average Inj Rate (M lb/hr) | Wellhead Press, psig | | Average Annulus N2 Press (psig) | Average Inj Temp (Deg F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Geofluid | Supp Wtr | Other | | Total | | Avg. | Max. | | |
| | | | | Code | Quantity | | | | | | |
| 01/01/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/02/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/03/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/04/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/05/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/06/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/07/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1230 | |
| 01/08/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/09/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/10/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/11/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/12/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/13/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/14/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/15/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/16/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/17/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/18/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/19/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/20/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1220 | |
| 01/21/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/22/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/23/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/24/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/25/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/26/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/27/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/28/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/29/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/30/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| 01/31/93 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1210 | |
| Mo. Total | 0 | 0 | 0 | | 0 | 0 | | | | | |

# PUNA GEOTHERMAL VENTURE

*A Hawaii Partnership*

October 10, 1992

Mr. Thomas Arizumi, Chief
Environmental Management Division
State Department of Health
P.O. Box 3378
Honolulu, Hawaii 96809

RECEIVED
92 OCT 12 A9:43
DIV. OF WATER & LAND DEVELOPMENT

SUBJ: UIC PERMIT NO. UH-1529

Dear Tom,

Enclosed is a copy of a report on recent mechanical integrity tests of Well KS-1A. The tests were performed in August and September, 1992, in accordance with PGV's Casing Monitoring Program and conclusively demonstrate the mechanical integrity of the well. The tests were done without the hangdown string in place. We expect to install a 5-inch hangdown string this week and will request your final approval of the well for injection service when that work is completed.

Enclosed with each copy of the report are copies of the two temperature logs, the casing inspection caliper log and the pressure recorder chart from the casing pressure test.

Also enclosed is the report for the casing integrity test of KS-3 containing the available test data. It is not in final form as we are still waiting on the drafted surveys. As soon as these are available they will be sent to you. However, all the data is attached for your review and computer printed graphs are included.

If you wish to discuss the test results or need additional information, please call Bob Verity or myself.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

cc: Steve Morris, PGV (w/ encl.)
Manabu Tagamori, DLNR (w/ encl.)
File: KS-1A (w/o encl.)

Memo: a:21394

# PUNA GEOTHERMAL VENTURE

*A Hawaii Partnership*

RECEIVED

92 OCT 7 P2:42

DIV. OF WATER & LAND DEVELOPMENT

October 5, 1992

Mr. Manabu Tagamori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

SUBJ: KS-1A FIVE INCH HANGDOWN LINER MODIFICATION

Dear Manabu,

Puna Geothermal Venture (PGV) hereby submits a modification plan to install a 5" hangdown liner in Well Kapoho State 1A (KS-1A) for your information and approval.

Please call me if you have any questions or would like additional information.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

/cm

cc: S. Morris

File: 14.3.1
Memo: 21382

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 30, Pahoa, Hawaii 96778

5 INCH HANGDOWN LINER:WELL KS-1A

5 INCH CASING TO BE RUN UTILIZING A CRANE

1. MOVE IN AND RIG UP EQUIPMENT FOR RUNNING A 5 INCH HANG DOWN LINER IN WELL KS-1A.

2. RIG UP OVER THE EXISTING WELLHEAD VALVE WITH A DOUBLE RAM BLOWOUT PREVENTER AND HYDRIL. TEST PREVENTER AND HYDRIL AGAINST THE WELLHEAD VALVE TO 1500 PSI. HAVE THE BOP TEST WITNESSED BY A REPRESENTATIVE OF DLNR.

3. INSTALL OVER THE TOP OF THE HYDRIL A WORKING PLATFORM SUITABLE FOR RUNNING TUBING AND CASING.

4. POSITION A 100 TON CRANE ON LOCATION SO THAT IT CAN PICK UP AND RUN IN THE HOLE 3 1/2 INCH DRILL PIPE AND 5 INCH CASING. IT MAY BE NECESSARY TO HAVE A SMALLER CRANE ON LOCATION TO PICK UP PIPE AND THE 150 TON CRANE SO POSITIONED THAT ITS ONLY FUNCTION WILL BE TO RUN PIPE IN AND OUT OF THE WELL. THE TOTAL WEIGHT OF THE 5 INCH STRING IN AIR WILL BE 91000 LBS.

5. KILL WELL WITH WATER AND KEEP DEAD.

   5A. PICK UP RTTS TOOL AND RUN IN HOLE WITH 3 1/2 INCH DRILL PIPE TO A DEPTH SUFFICIENT TO SET THE RTTS INSIDE THE 7 INCH CASING. RUN RTTS WITH SUB SEA VALVE INSTALLED AND BOPE ON TOP OF DRILL PIPE. PRESSURE TEST AGAINST THE RTTS TOOL TO 2000 PSI.

   5B. KEEP WELL DEAD WITH WATER THROUGH 3 1/2 INCH DRILL PIPE AND RTTS.

6. NIPPLE DOWN BOPE AND MASTER VALVE; REMOVE WORK PLATFORM.

   6A. CLOSE DRILL PIPE BOP AND DISCONTINUE INJECTION. STRIP BOPE AND MASTER VALVE OFF OF EXPANSION SPOOL OVER THE 3/1/2 INCH DRILL PIPE.

   6B. STRIP 8 INCH HANGER SPOOL, MASTER VALVE AND BOPE ON TO EXPANSION SPOOL. RESUME WATER INJECTION THROUGH 3 1/2 INCH DRILL PIPE TO KEEP WELL DEAD.

   6C. NIPPLE UP HANGER SPOOL, MASTER VALVE AND BOPE.

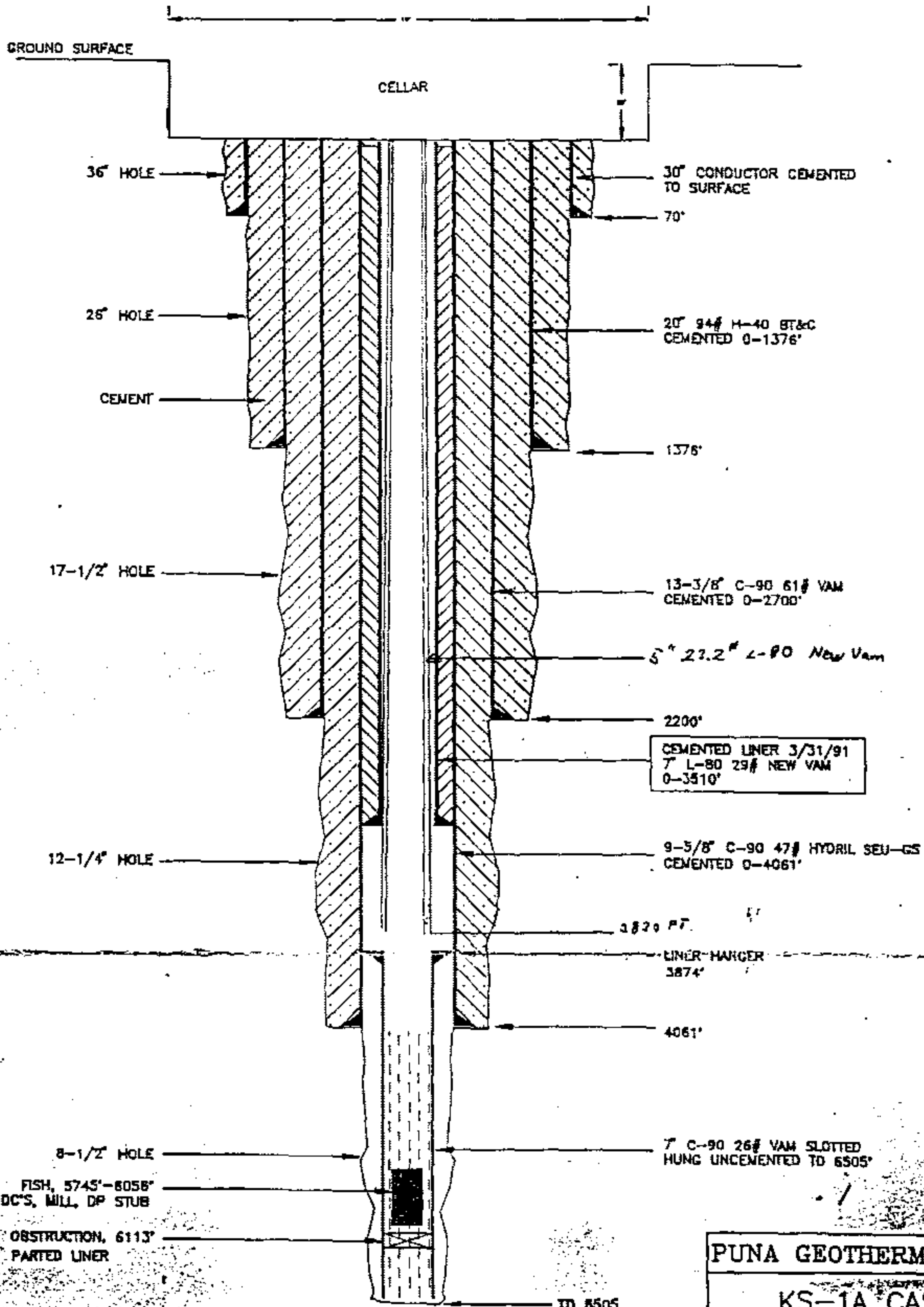
   6D. REINSTALL WORK PLATFORM.

7. PRESSURE CHECK BOP'S, MASTER VALVE, AND NEWLY INSTALLED LINER HANGER TO 2000 PSI. HAVE THE TEST OF BOP EQUIPMENT WITNESSED BY DLNR REPRESENTATIVE.

8. RETRIEVE RTTS TOOL FROM 7 INCH CASING. PULL OUT OF HOLE LAYING DOWN 3 1/2 INCH DRILL PIPE. SHUT DOWN OPERATIONS UNTIL MORNING, KEEP WELL DEAD BY PUMPING COLD WATER.

9. RIG UP TO RUN 5 INCH CASING. KEEP WELL DEAD BY PUMPING COLD WATER. CASING IS TO BE RUN WITH A CRANE UTILIZING A CASING CREW TO MAKE UP AND RUN THE CASING. THE CASING WILL BE RUN KEEPING THE WELL DEAD BY CONTINUALLY PUMPING COLD WATER INTO THE WELL THROUGH THE 3 INCH WING VALVES ON THE 9 5/8 INCH EXPANSION SPOOL. RIG UP AND RUN 3730 FT. OF 5 INCH, 23.20#/FT, L-80, NEW VAM CASING. HANG CASING IN DONUT ON 8 INCH BY 5 INCH DONUT HANGER USING 5 INCH DRILL PIPE TO LAND DONUT. BACK OFF DRILL PIPE FROM LINER HANGING DONUT AND SECURE LINER HANGER IN SPOOL WITH LOCK DOWN NUTS.

10. RIG UP AN AIR COMPRESSOR TO THE 5 INCH BY 7 INCH ANNULUS AND PRESSURIZE THE ANNULUS WITH AIR TO THE SHOE OF THE 5 INCH CASING. OBSERVE THE ANNULUS PRESSURE FOR LEAKS, ONCE THE ANNULUS IS SECURED, NIPPLE DOWN BOPE AND WORK PLATFORM RELEASE CRANE AND CREWS FROM LOCATION.




PUNA GEOTHERMAL VENTURE

KS-1A CASING SCHEMATIC AFTER REWORK

| | | |
|---|---|---|
| DATE 5/13/91 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO.4 |

FLOOD CONTROL & MINERAL RESOURCE BRANCH
Division of Water and Land Developm

6/92

FROM: J. Florez DATE: Dec 16, 1992 FILE IN: KS-1A Well Record

| TO: | INITIAL: | | PLEASE: | REMARKS: |
|---|---|---|---|---|
| | | G. AKITA | ___ See Me | |
| | | L. Choo | ___ Call | |
| | | | ___ Review & Comment | |
| | | T. Kam | ___ Take Action | |
| | | H. Young | ___ Investigate & Report | |
| | | S. Yong | ___ Draft Reply | |
| | | C.P. Chang | ___ Acknowledge Receipt | |
| | | Y.F. Xu | ___ Type Draft | |
| | | T. Nakama | ___ Type Final | |
| | | J. Swift | ___ Xerox ___ copies | |
| | | J. Florez | X please file | |
| | | M. Tanouye | | |
| X | | C. D'Araujo | | |

FOR YOUR:

| | | | | |
|---|---|---|---|---|
| | | M. TAGOMORI | | |
| | | L. Nanbu | ___ Approval | |
| | | L. CHANG | ___ Signature | |
| | | E. LAU | ___ Information | |
| | | A. Monden | ___ File | |
| | | G. Miyashiro | | |
| | | D. Lee | REQUESTED BY: | |

DATE

PUNA GEOTHERMAL VENTURE
MECHANICAL INTEGRITY TESTS OF WELL KS-1A
August and September 1992

## Summary

Mechanical integrity tests consisting of shut-in temperature logs, a casing pressure test and a casing caliper log were performed on injection well KS-1A in August and September, 1992. The tests confirmed that there is no casing leak and no interzonal communication behind casing.

## Casing Pressure Test

The KS-1A casing was pressure tested with compressed air to 1,400 psig at the wellhead beginning at 1745 hrs on September 25, 1992. The well was pressurized through a wing valve on the wellhead with a drilling compressor, and then the valve was shut and remained shut for the duration of the test. As shown on the attached copy of the pressure recorder chart, the pressure held with no leakoff for 37.5 hours until the test was terminated at 0720 hrs on September 27. (With regard to the recorder chart, note that the pressure element range is 0 - 2,000 psi and the chart range is 0 - 500, so the chart readings must be multiplied by a factor of 4.) The pressure recorder readings were confirmed with a conventional pressure gauge.

Figure 1 is a graph showing the normal static pressure profile in the well and a linear approximation of the pressure profile of air with a 1,400 psig wellhead pressure. The figure shows that the water level in the wellbore was depressed to 4,580 ft, which is 519 ft below the casing shoe at 4,061 ft (Figure 2). This indicates clearly that there is no leakage around the casing shoe and that there is virtually no permeability in the formation between the casing shoe and 4,580 ft.

## Shut-in Temperature Logs

Shut-in temperature logs were run in KS-1A on August 19 and 20, 1992, following injection of produced geothermal fluid during the flow test of production well KS-8. Prior to the temperature logs, KS-1A had been on injection for five days at wellhead pressures in the range of 0 - 220 psig and an average injection water temperature of about 145°F. It was shut in at 2015 hrs on August 18, 1992, immediately following termination of the KS-8 flow test. The first temperature log was run beginning at 2340 hrs on August 19, 27.4 hours after shut-in. The second was run on August 20, 38 hours after shut-in. Both logs are plotted in Figure 3, along with the true static temperature profile. The static profile was run in 1990, when there was a cement plug in the casing at 3,542 ft. It is the most representative static temperature profile for the well. Although it does not cover the entire cased interval, it is adequate as a reference profile for shut-in temperature logs.

The recent logs show normal thermal recovery following injection and give no indication of fluid communication behind casing. The temperature spike at 3,800 ft (about 250 ft above the casing shoe) is characteristic of the rapid reheating that occurs where a fracture carrying high-temperature geothermal fluid intersects the wellbore. This rapid recovery indicates there was no invasion by injected water and further confirms cement integrity at the casing shoe. The sharp dropoff in temperature at 4,600 ft indicates that injected water is entering the formation at that depth and below. Above 4,600 ft, the formation is apparently not taking injected water, which is consistent with the fact that the casing pressure test indicated no permeability in the formation between the shoe and 4,580 ft.

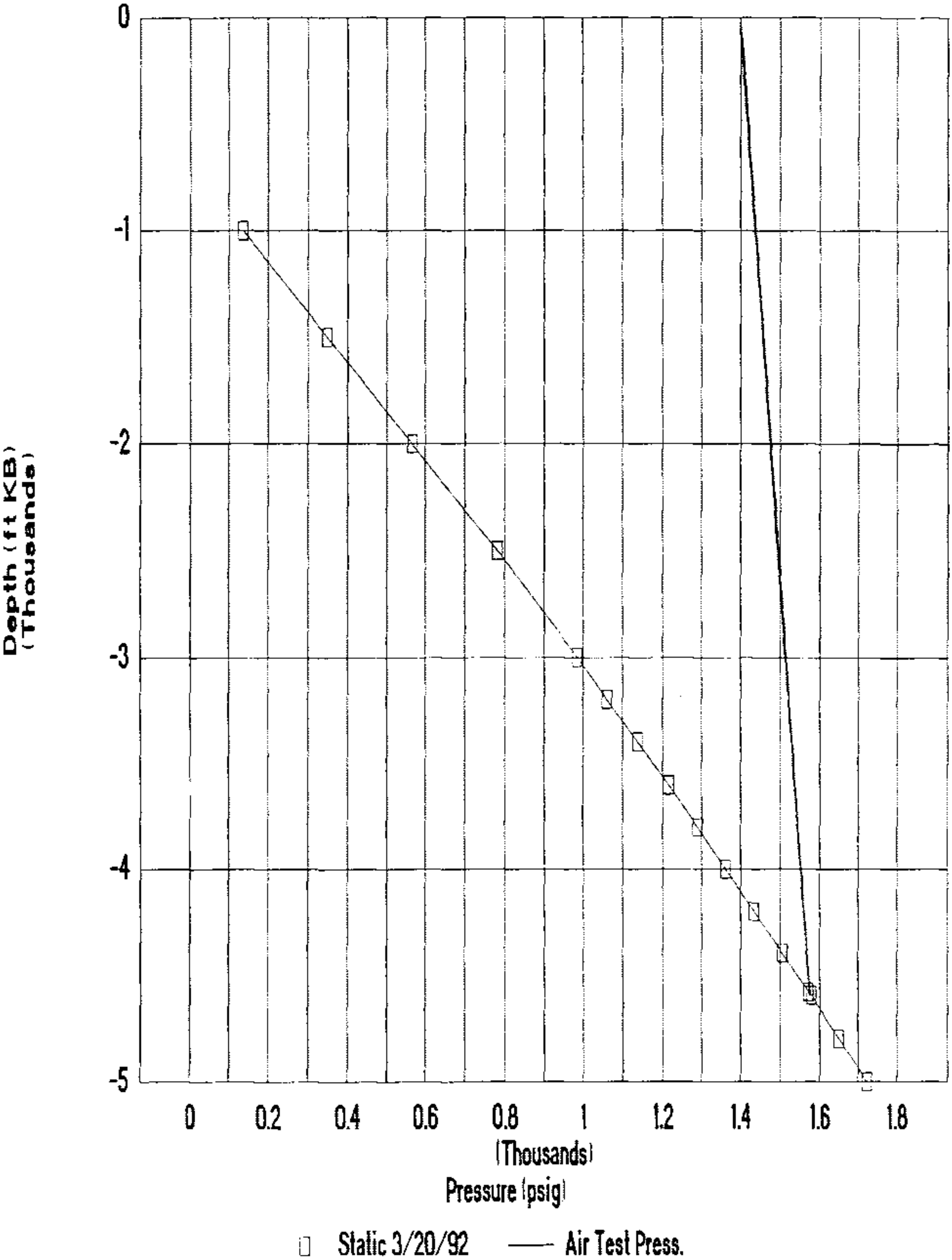
Casing Caliper Log

On September 30, 1992, a casing inspection caliper log was run in the 7-inch tieback casing in KS-1A. This log was not required under PGV's Casing Monitoring Program, but PGV chose to run it for a more complete evaluation of the well. The log indicates no significant irregularities in the casing.

Figure 1

# KS-1A STATIC PRESSURE

## AND AIR TEST PRESSURE



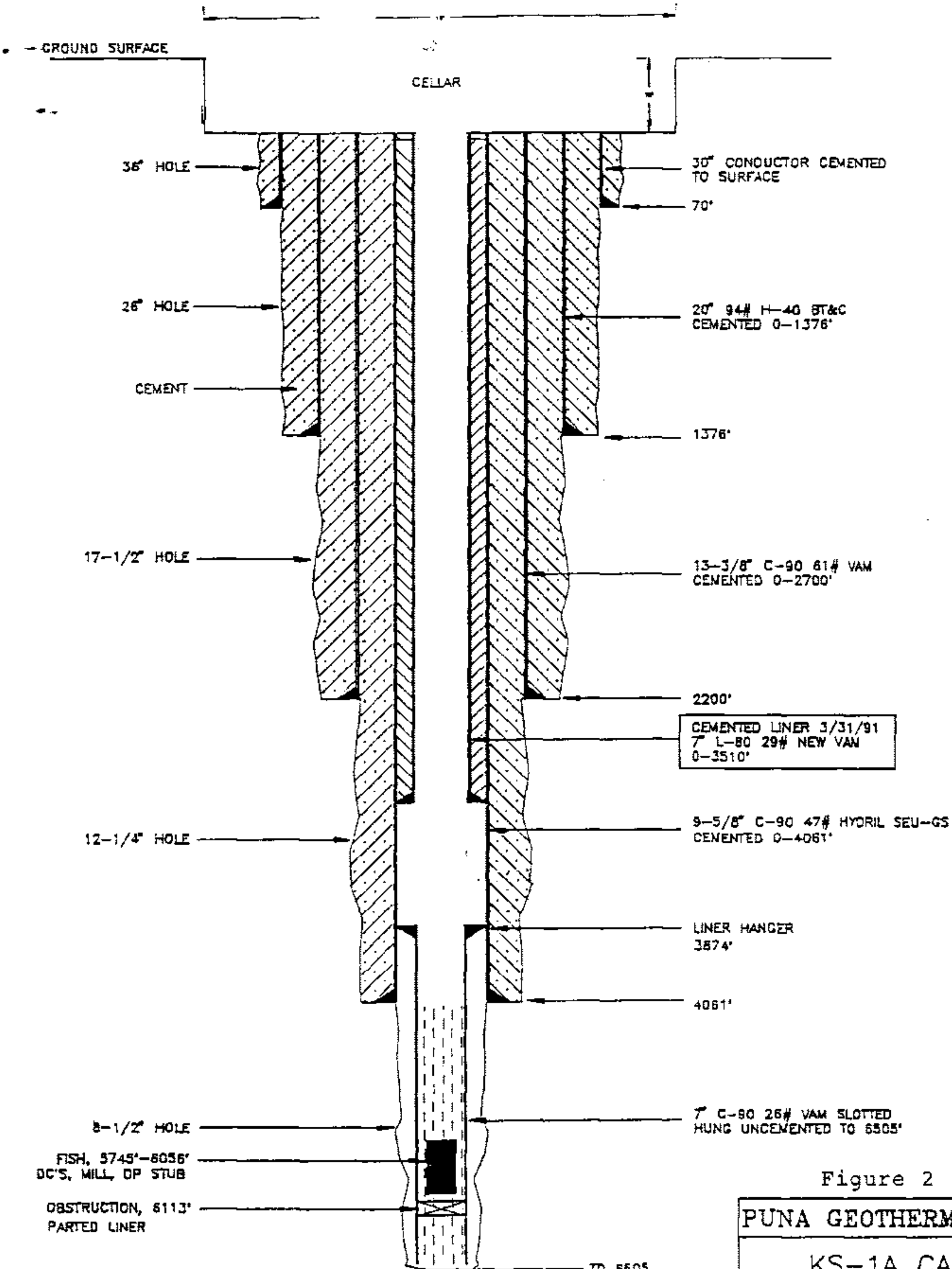



Figure 2

| PUNA GEOTHERMAL VENTURE | | |
|---|---|---|
| KS-1A CASING SCHEMATIC AFTER REWORK | | |
| DATE 8/28/92 | | REV. 1 |
| BY W. TEPLOW | FILE: KS1ACAS.DWG | FIGURE NO. |

ure 3

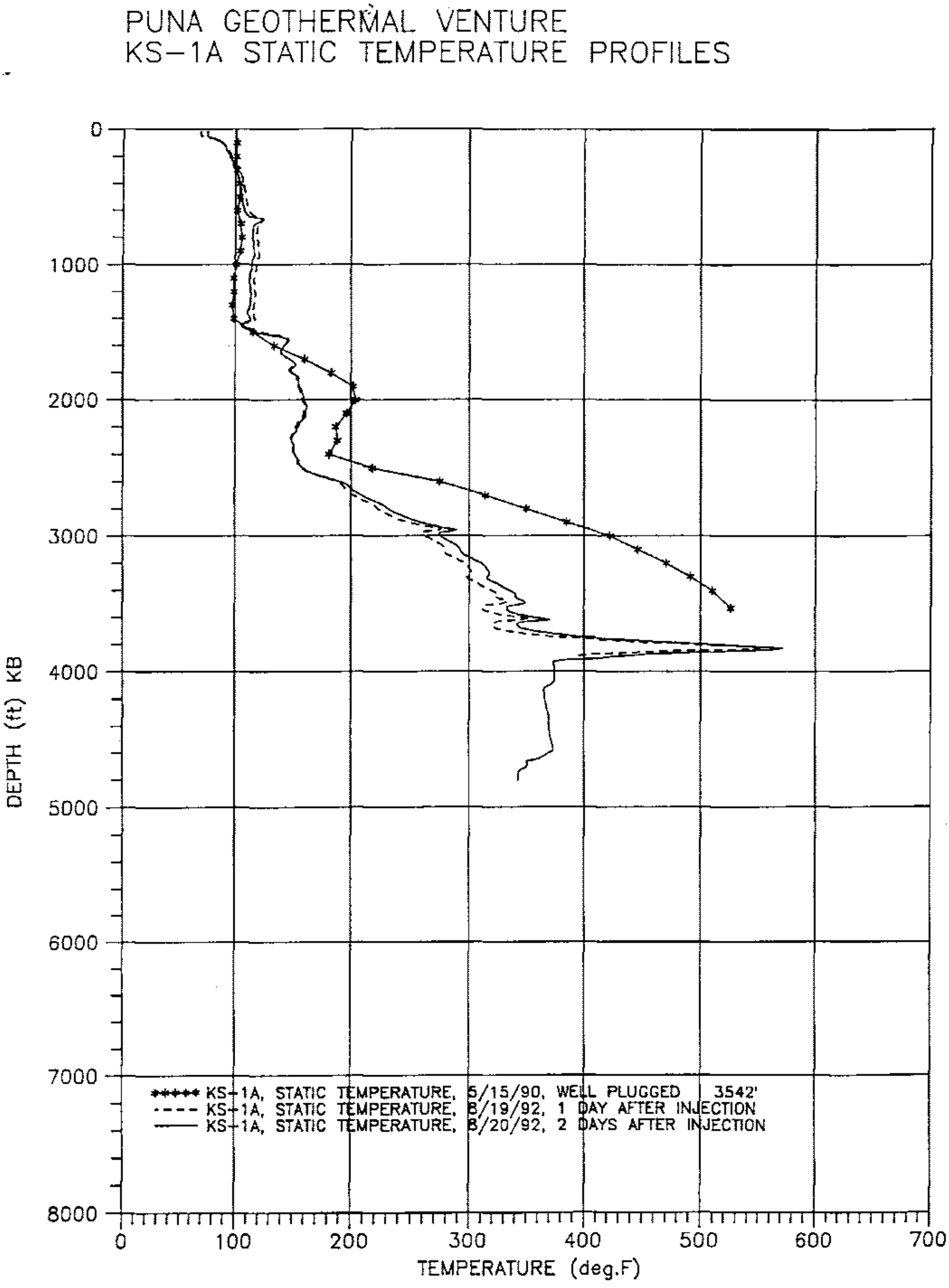



FIGURE 1

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management

## CASING PRESSURE TEST

Instructions: Please print or type and send completed form with any attachments to Division of Water Resource Management, P.O. Box 373, Honolulu, Hawaii 96809.

Reference DLNR Regulations:

§13-183-76 (b) All casing strings shall be pressure tested after cementing and before commencing any other operations on the well. Minimum casing test pressure shall be approximately one-third of the manufacturer's rated internal yield pressure; provided that the test pressure shall not be less than six hundred pounds per square inch and greater than 1500 pounds per square inch. In cases where combination strings are involved, the above test pressures shall apply to the lowest pressure-rated casing used. Test pressures shall be applied for a period of thirty minutes. If a drop of more than ten percent of the test pressure should occur, the casing or cement job shall be considered defective and corrective measures shall be taken before commencing any further operations on the well.

**Casing Pressure Test:**

1. Project name Puna Geothermal Venture
2. Drilling company Parker Drilling Company
3. Well name and number Kapoho State #03
4. Location Puna District
5. Person(s) taking test Daniel Weingarten
6. Date of test 10-1-92
7. Time of test 2100 hrs.
8. Depth of hole 3642 to top of landing collar Shoe @ 3724
9. Size of last casing string 7" L-80 29#
10. Depth to top of casing (Casing Lap) Surface
11. Depth to bottom of casing (Casing Shoe) 3724

12.(a) Pressure at which casing tested (to Master Valve) 2000#

(b) Drop in Pressure to (after 30 minutes) 100#

13.(a) Pressure at which Blind Rams tested 2000#

(b) Drop in Pressure to (after 30 minutes) -0-

14.(a) Pressure at which Pipe Rams tested 2000#

(b) Drop in pressure to (after 30 minutes) -0-

Other Information: (use additional sheet, if necessary).
All other valves applicable to well head expansion spool and 7" x 11" casing hanger spool. 2000# OK Also tested Hy 2000#

Permit No. UH-1529

AUTHORIZATION TO OPERATE UNDER THE
UNDERGROUND INJECTION CONTROL PROGRAM

In compliance with the provisions of the Safe Drinking Water Act, Chapter 340E, Hawaii Revised Statutes (HRS), as amended, and Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control;

PUNA GEOTHERMAL VENTURE

is authorized to operate a Class V, Subclass B, geothermal reinjection well system consisting of two (2) reinjection wells; known as geothermal wells Kapoho State 1A (KS-1A) and Kapoho State 3 (KS-3):

| Reinjection Well No. | Located on Well Pad | Approx. Wellhead Elevation Above Mean Sea Level |
|---|---|---|
| KS-1A | A | 617 feet |
| KS-3 | E | 618 feet |

and having the specifications as listed in Figure No. 1 and Figure No. 2, respectively; to reinject the geothermal fluids consisting of geothermal brine, geothermal steam condensate, and geothermal noncondensible gases which are produced during the operation of the well field and power plant; and the intermittent inclusion of reinjection supplement water; back into the geothermal reservoir at an interval between the approximate depths of 3,900 feet and 7,300 feet;

located at the facility's address of 14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778; at Tax Key Number, 3rd Div. 1-4-01:2 and 19; at the approximate well pad coordinates:

Well Pad A: Latitude 19° 28' 49" N and Longitude 154° 53' 35" W;
Well Pad E: Latitude 19° 28' 41" N and Longitude 154° 53' 40" W;

in accordance with monitoring requirements and other conditions set forth in Parts I, II and III hereof.

This permit will become effective upon issuance.

This permit and the authorization to operate the reinjection wells will expire at midnight,

Issued on the day of

DRAFT

(For) Director of Health

A. THE OPERATION OF THE REINJECTION WELLS SHALL BE LIMITED TO:

1. Effluent Characteristics

The reinjection of geothermal fluids consisting of geothermal brine, geothermal steam condensate, geothermal noncondensible gases and reinjection supplement water that may include the chemical parameters as listed in Table No. 1 as being representative of the geothermal fluid.

2. Reinjection Limitations

(a) Reinjection Pressure:
The reinjection pressure as measured at the well head shall not exceed 500 psi gauge or the fracture pressure of the receiving formation, whichever is less.

(b) Reinjection Quantity and Rate:

The reinjection quantity and rate shall be commensurate with the production of up to twenty-five (25) megawatts, net power.

The maximum reinjection rate shall be limited to a total of approximately 675,000 lbs./hr. with the approximate composition of:

| | |
|---|---|
| Steam Condensate | 505,816 lbs./hr. |
| Brine | 128,250 lbs./hr. |
| Supplement Water and/or Brine from the Storage Pits | 39,751 lbs./hr. |
| Total Noncondensible Gases | 1,183 lbs./hr. |
| Total | 675,000 lbs./hr. |

The maximum quantity of injectate, based on any 24-hour period of operation, shall not exceed 16,200,000 lbs.

(c) Concentrations of the Effluent:

The concentrations of the chemical parameters of the geothermal fluid listed in Table No. 1 are recognized as being variable and peculiar to the geothermal resource and the processes of geothermal energy production. Therefore, concentrations as such, for the purpose of setting maximum chemical levels, are not listed in this permit; however, chemical analyses are required as detailed in Part I, Section B of this permit.

(d) Prohibited From Reinjection:

There shall be no reinjection disposal of fluids other than the geothermal fluid and reinjection supplement water as described in Part I, Section A.1. Furthermore, there shall be no reinjection disposal of:

- Hazardous wastes without the prior written authorization of the Director;

- Domestic wastewater as defined in Hawaii Administrative Rules, Title 11, Chapter 62, "Wastewater Systems"; and

- Any designed chemical inclusion to the geothermal fluid unless recognized and approved by this permit.

B. MONITORING AND REPORTING REQUIREMENTS:

1. Injectate and Reinjection Well Monitoring

(a) Samples and measurements taken as required herein shall be representative of the volume and nature of the geothermal fluid and reinjection supplement water.

Detailed records of the operation of the reinjection wells shall be kept by the operator. Records shall include, but not be limited to, the following information:

(1) Type of injectate;
(2) Quantity of injectate;
(3) The method of reinjection;
(4) The rate of reinjection;
(5) Reinjection pressure for wells situated in caprock areas overlying volcanic aquifers under artesian pressure.
(6) The exact date and time of the measurement;
(7) The person(s) who performed the measurement;
(8) The dates the analyses were performed;
(9) The person(s) who performed the analyses;
(10) The analytical techniques or methods used;
(11) The results of all required analyses and permit limits;

(b) A daily record of the injectate quantity being discharged into the reinjection wells shall be maintained. Injectate quantity recordings shall be continuously made with the use of instruments that directly measure and record the flow of the injectate.

(c) When reinjection supplement water is being used, a record of the reinjection supplement water quantity being discharge into the reinjection wells shall be maintained. The recordings shall be continuously made with the use of instruments that directly measure the flow of the supplement water.

(d) Representative samples (three types) of the injectate shall be collected from a collection point to be established by the facility and approved by the Department, and analyzed as described:

Type I Sample:

(1) Type I samples shall be collected and analyzed at least once every 30 days.
(2) Type I samples shall be analyzed for the chemical parameters listed in Table No. 1.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type II Sample:

(1) Type II samples shall be collected and analyzed at least once every 90 days.
(2) Type II samples shall be analyzed for Ignitability, Corrosivity, Reactivity, and Method 1311: Toxicity Characteristic Leaching Procedure (TCLP) as described in 40 CFR, Part 261, Appendix II. Reference is hereby made to Table No. 2 which lists the chemical parameters for which analysis shall be conducted under Method 1311. Regulatory levels of the chemical parameters are listed for reference.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

Type III Sample:

(1) Type III samples shall be collected and analyzed at least once every 90 days.
(2) Type III samples shall be analyzed for volatile organic compounds as described in 40 CFR, Part 136, Appendix A, Method 624.
(3) The analytical results shall be submitted to the Department after each analytical event and a copy shall be kept on file at the facility.

(e) Laboratory analysis shall be conducted by a laboratory approved by the Department. Methods of analysis shall be as stated herein or approved by the Department.

(f) Regarding sample Type II and Type III, the permittee shall notify the Department at least seven (7) days prior to the date of sample collection. Any Type II and Type III samples which are collected without the acknowledgement and inspection by the Department will not serve to comply with the monitoring and reporting requirements of this permit.

(g) A reinjection well status report shall be submitted to the Department at least once every 90 days. The reinjection well status report shall describe the performance of the reinjection well and shall be the basis for the facility to establish continuous performance monitoring. The report shall be made by a professional engineer or geologist proficient in geothermal reinjection practices and geothermal energy production.

2. Upset Condition

(a) In the event of an upset of facility operations that would require the discharge of geothermal injectate to be diverted from the reinjection well to any other ground disposal system, such as a surface impoundment, a daily record of the quantity being discharged into the disposal system shall be maintained. Discharge quantity recordings shall be continuously made with the use of instruments that directly measure the flow of the effluent.

(b) A summary of the daily discharges resulting from each upset event shall be submitted to the Department within 15 days after the cessation of the upset event.

(c) Discharges of geothermal injectate to any ground disposal system does not preclude the implementation of all sampling, analyses, and reporting conditions of this permit.

3. Additional Monitoring and Reporting

If the operation of the reinjection wells is additionally regulated by other pollution control programs, e.g., National Pollutant Discharge Elimination System (NPDES), the adherence to those monitoring and reporting requirements shall be considered a requirement of this permit.

4. Records Retention

All records and information resulting from the monitoring activities required by this permit including all records of analyses performed, calibration and maintenance of instrumentation and recordings from continuous monitoring instrumentation shall be retained on site for a minimum of three (3) years from the date of the sample and shall be made available for inspection by the Director. This period may be extended by the request of the Director at any time.

5. Anticipated Changes

The permittee shall give advance notice to the Director of any planned changes in the permitted facility or activity which may change any operating characteristics or conditions of the reinjection wells; or which may result in noncompliance with the permit conditions.

6. Notification of Change in Ownership or Control

In the event of any change in ownership or control of the reinjection wells, the owner shall report the change to the Director in writing at least one month prior to closing. Until such time as the permit is revoked and/or reissued, the permittee of record shall be responsible for the operation of the reinjection wells and for damages resulting from improper operation of the reinjection wells.

7. Twenty-Four Hour Reporting

The permittee shall report any deviation from the permit, including:

(a) Any monitoring, or other information, which indicates that any contaminant may cause an endangerment to a USDW; or

(b) Any noncompliance with a permit condition or malfunction of the injection system which may cause fluid migration into or between USDWs.

Such information shall be provided orally within 24 hours or the next business day of the Department from the time the permittee becomes aware of the circumstances. A written submission shall also be provided within five (5) days of the time the permittee becomes aware of the circumstances. The written submission shall contain a description of the noncompliance and its cause, including exact dates and times, and if the noncompliance has not been corrected, the anticipated time it is expected to continue; and steps taken or planned to reduce, eliminate and prevent reoccurrence of the noncompliance.

Oral reports shall be made to the Safe Drinking Water Branch at (808)586-4258 (Honolulu) or call toll free from the neighbor islands at 1-800-468-4644, ext. 64258. In addition, for neighbor island occurrences, the Safe Drinking Water Branch Sanitarian shall be notified at (808)933-4552. The Director may waive the written report on a case-by-case basis if the oral report has been received immediately.

8. Definitions

(a) The "Department" means the Department of Health, State of Hawaii.

(b) The "Director" means the Director of Health or a duly authorized representative.

(c) "Facility or activity" means any UIC "reinjection well" or any other facility or activity that is subject to regulation under the UIC Program.

(d) "Fluid" means any material or substance which flows or moves whether in a semisolid, liquid, sludge, gas or any other form or state.

(e) "Hazardous waste" means the same as defined in HRS, Chapter 342J-2 and state administrative rules.

(f) "Reinjection well" means a "well" into which "fluids" are being emplaced or reinjected.

(g) "Reinjection pressure" means the head increase in the well bore with respect to static groundwater level.

(h) "USDW" means "underground source of drinking water" as defined in Hawaii Administrative Rules, Title 11, Chapter 23, Underground Injection Control.

A. MANAGEMENT REQUIREMENTS:

1. Change in Discharge

All operations of the reinjection wells authorized herein shall be consistent with the terms and conditions of this permit. The operation of the reinjection wells identified in this permit at volumes in excess of that authorized shall constitute a violation of the permit conditions. Any anticipated facility expansions, production increases, or process modifications which will result in new, different, or increased discharges of pollutants must be reported by submission of a new UIC application or, if such changes will not violate the effluent limitations specified in this permit, by notice to the permit issuing authority of such changes. Following such notice, the permit may be revoked or modified to specify and limit any pollutants not previously limited.

2. Signatory Requirements

All reports or information submitted to the Director shall be signed and certified in accordance with Title 11, Chapter 23, Underground Injection Control, Section 12(b), Hawaii Administrative Rules.

3. Availability of Reports

All reports prepared in accordance with the terms of this permit shall be available for public inspection, with the approval of the Director, at the offices of the Director. Permit applications, permits, and well operation data shall not be considered confidential.

4. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to operate the reinjection wells. Proper operation and maintenance include, but are not limited to, effective performance, adequate funding, adequate operator staffing and training, adequate laboratory and process controls, including appropriate quality assurance procedures.

5. Reapplication

If the permittee desires to continue an activity regulated by this permit after the expiration date of this permit, reapplication shall be made on the application forms then in use. This reapplication should be made not later than 180 days before this permit expires in order to facilitate processing of the renewal.

6. Abandonment Requirements

The owner who wishes to abandon the reinjection wells shall submit an application containing the details of the proposed abandonment. The Department will review the application and may require an abandoned well to be plugged in a manner which will not allow detrimental movement of fluids between formations. Abandonment procedures shall also comply with other applicable regulations of the Department of Land and Natural Resources.

B. GENERAL CONDITIONS

1. Operating Conditions

(a) No reinjection wells shall be operated, modified or otherwise utilized without a UIC permit issued by the Department.

(b) No person shall construct, operate, maintain, convert, plug, abandon or conduct any other reinjection activity in a manner which allows the movement of fluid containing a contaminant into underground sources of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water rule or may otherwise adversely affect the health of one or more persons.

(c) The reinjection wells shall be operated in such a manner that does not violate any of Title 11, Hawaii Administrative Rules, regulating various aspects of water quality and pollution, and Chapter 342, HRS. The rules include:

(1) Chapter 11-20, "Potable Water Systems";
(2) Chapter 11-55, "Water Pollution Control"; and
(3) Chapter 11-62, "Wastewater Systems".

(d) If at any time the Department learns that a reinjection well may cause a violation of primary drinking water rules, the Department shall order the owner to take such actions as may be necessary to prevent the violation, including, where required, cessation of operation of the reinjection well.

(e) Notwithstanding any other provision of this section, the Department shall issue a cease and desist order, effective immediately, upon receipt of information that a contaminant which is present in, or likely to enter, a system supplying water for human consumption, poses an imminent and substantial danger to the health of a person or persons.

2. Permit Issuance

A copy of this permit shall be retained by the facility and shall be made available for inspection by the Director.

This UIC permit shall not be transferable from the reinjection well owner to any other person.

This UIC permit shall be subject to revocation, suspension or revision by the Director if, after notice and opportunity for a contested hearing, it is determined that:

(a) There is a violation of any term or condition of the UIC permit; or

(b) The UIC permit was obtained by misrepresentation, or failure to fully disclose all relevant facts; or

(c) The UIC permit was willfully defaced, altered, forged or falsified; or

(d) There is a change in any condition that requires either a temporary or permanent reduction or elimination of the permitted reinjection; or

(e) There is a failure to comply with these rules or any other applicable rules or laws.

All permit conditions will remain in effect despite the filing of a request by the permittee for a permit revocation and reissuance, or termination, or a notification of planned changes or anticipated noncompliance.

3. Permit Modification

Any modification, alteration, or change to this permit shall be made only by written supplement or reissuance of the permit by the Department.

4. Duty to Mitigate

The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

5. Property Rights

   The issuance of this permit does not convey any property rights in either real or personal property, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

6. The Director shall have the right to enter premises on which any reinjection well system is located; to inspect any equipment, operation, or sampling of any reinjection well system; to take effluent samples from any reinjection well system; and to have access to and copy any record required to be kept pursuant to this permit.

7. Need to Halt or Reduce an Activity not a Defense

   It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

8. Penalties

   It shall be a violation of Chapter 11-23 for any owner or operator of a reinjection well to construct, operate, maintain or close that well unless authorized by this chapter or by a permit or order to do so. It shall also be a violation of this chapter for any owner or operator to fail to comply with all of the applicable terms of the authorization, including those relating to inspection, monitoring, record keeping, and reporting. Compliance with a corrective order shall not excuse the basic violation. Any person who violates any provision of this chapter on the permit shall be subject to the penalties provided in section 340E-8, HRS or section 11-23-21, HAR.

9. Severability

   The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

A. OTHER REQUIREMENTS:

1. This permit shall be further subjected to the following provisions:

   (a) The implementation of the "Hydrologic Monitoring Program" prepared by Science Applications International Coporation dated April 1990, or as modified with the written approval of the Department.

   (b) The implementation of the "Production and Reinjection Well Casing Monitoring Program" prepared by Puna Geothermal Venture, completed in November 1991, or as modified with the written approval of the Department.

   (c) This permit herein acknowledges that conditions affecting the Hydrologic Monitoring Program and the Production and Reinjection Well Casing Monitoring Program could warrant the reevaluation of the monitoring programs to address changing concerns. Modifications to the monitoring programs, resulting from reevaluations, shall be approved by the Department before implementation.

Figure No. 1

(KS-1A)

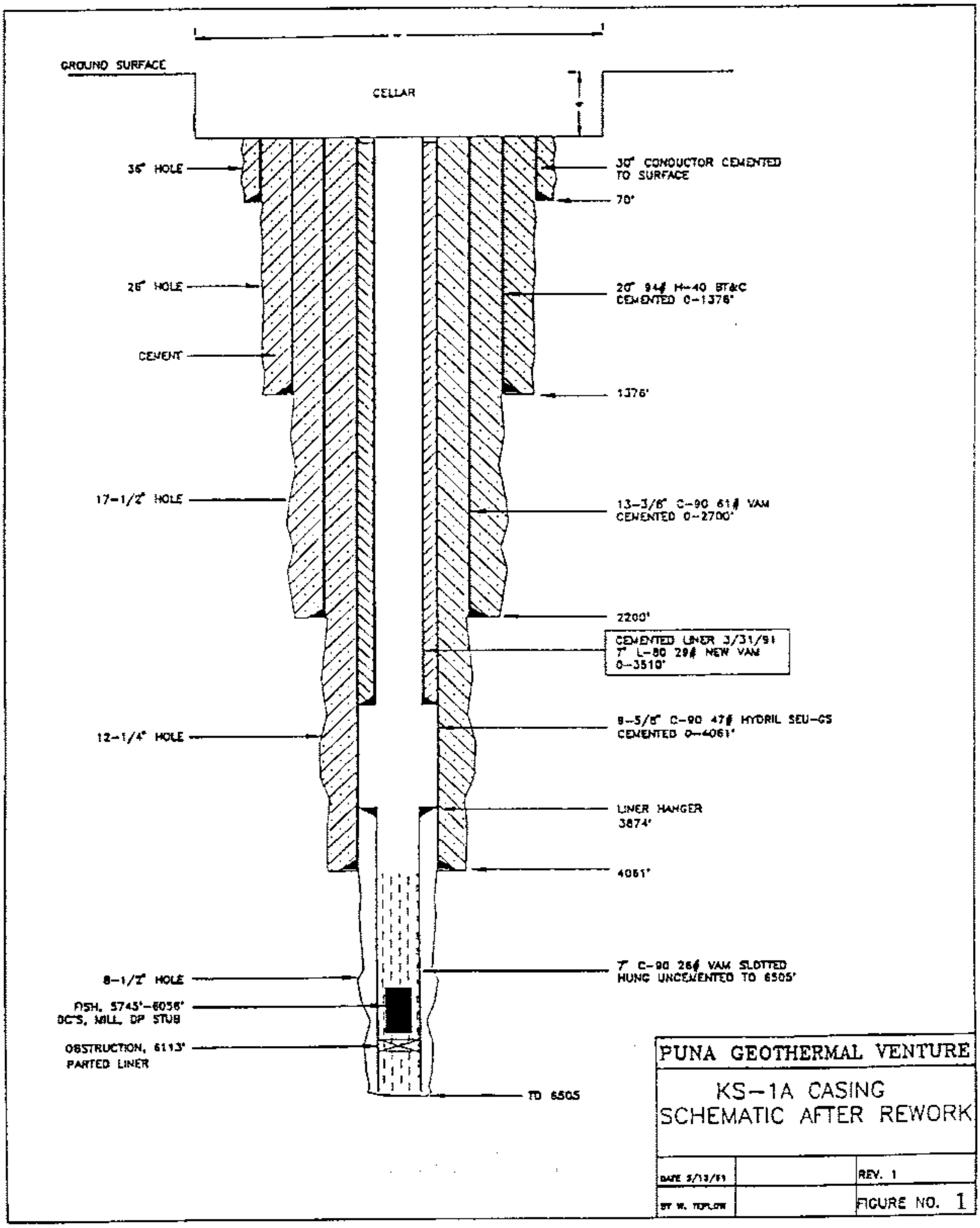
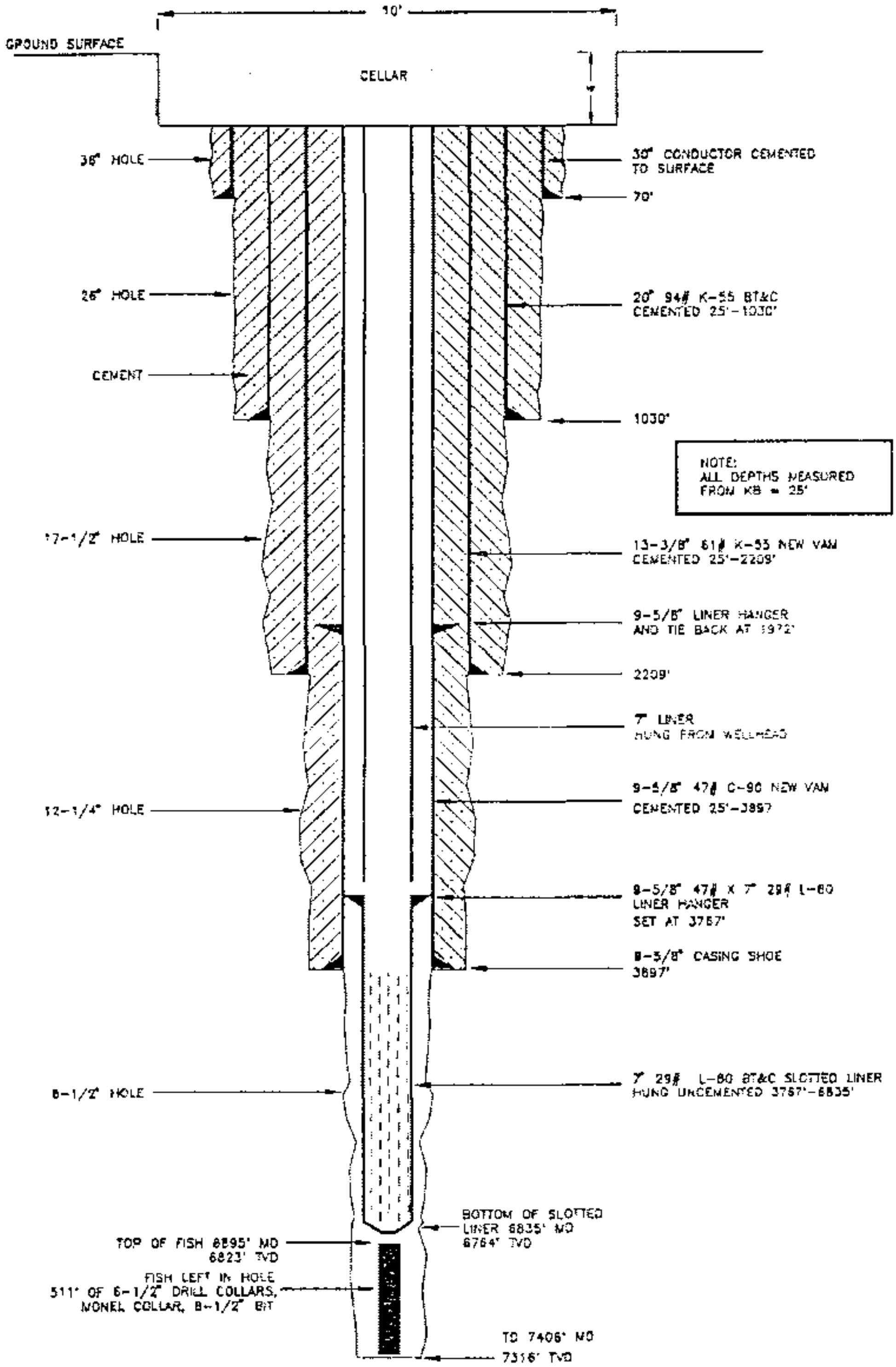


Figure No. 2

(KS-3)






| PUNA GEOTHERMAL VENTURE | | |
|---|---|---|
| INJECTION WELL KS-3 CASING DESIGN | | |
| DATE 6/22/92 | | REV. 1 |
| BY STERNFELD | FILE: PGV\KS3CAS.DWG | FIGURE NO. 2 |

FLOOD CONTROL & MINERAL RESOURCE BRANCH 6/9

Division of Water and Land Developn

FROM: Hirai DATE: FILE IN:

| TO: | INITIAL: | | PLEASE: | REMARKS: |
|---|---|---|---|---|
| 1 | | G. AKITA | See Me | 1. [illegible] |
| | | L. Choo | Call | Note [illegible] |
| | | | ✓ Review & Comment | [illegible] |
| | | T. Kam | Take Action | |
| | | H. Young | Investigate & Report | |
| | | S. Yong | Draft Reply | |
| | | C.P. Chang | Acknowledge Receipt | |
| | | Y. Xu | Type Draft | |
| | | T. Nakama | Type Final | |
| | | J. Swift | Xerox ___ copies | |
| | | J. Florez | | |
| | | M. Tanouye | | |
| | | C. D'Araujo | | |
| 2 | | M. TAGOMORI | | |
| | | L. Nanbu | | |
| | | L. CHANG | | |
| | | E. LAU | | |
| | | A. Monden | | |
| | | G. Miyashiro | | |
| | | D. Lee | | |

REQUESTED BY:

DATE

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# UNA GEOTHERMAL VENTURE
*Hawaii Partnership*

KS-

April 10, 1992

John C. Lewin, M.D.
Director
Department of Health
P.O. Box 3378
Honolulu, HI 96801

SUBJ: UNDERGROUND INJECTION CONTROL (UIC)
UIC APPLICATION NO. UH-1529

Dear Dr. Lewin:

Pursuant to the Department of Health (DOH) letter of March 16, 1990, to Puna Geothermal Venture (PGV) which outlined the requirements necessary for issuance of an Underground Injection Control (UIC) Permit to Operate (UIC Application No. UH-1529), PGV respectfully submits the following:

For Well Kapoho State 1A (KS-1A)

1) Engineering/Geologic Report
2) Casing Monitoring Program

The Hydrologic Monitoring Program for KS-1A was submitted in April of 1990.

For Well Kapoho State 3 (KS-3)

1) Casing Inspection and Injection Test Report

Items previously submitted for KS-3 were a Hydrologic Monitoring Program (April, 1990), a Casing Monitoring Program (November 21, 1991) and an Engineering/Geologic Report (November 12, 1991).

Based on these submittals, Puna Geothermal Venture respectfully requests that we be issued an Underground Injection Control Permit (UIC Application No. UH-1529) and Permits to Operate Injection Wells Kapoho State 1A (KS-1A) and Kapoho State 3 (KS-3).

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 1337, Hilo, Hawaii 96721-1337

John C. Lewin, M.D.
Page 2
April 10, 1992

If you have questions or require additional information, please contact me.

Sincerely,

Thomas G. Kizis

Thomas G. Kizis
Environmental Manager

TK/vla

cc: W. Paty, DLNR
C. Hew, DOH
M. Tagamori, DLNR
J. Swift, DLNR
J. Florez, DLNR
E. Tanaka, DLNR
R. Nakano, HCPD
S. Morris, PGV
D. Berube, PGV
B. Rickard, PGV
J. Sternfeld, PGV

**Memo No:** B21202
**Files:** KS-1A, KS-3, UIC

# PRODUCTION AND INJECTION WELL CASING MONITORING PROGRAM

## 1. INTRODUCTION

### 1.1 Background

Pursuant to Underground Injection Control (UIC) Permit No. UH-1529, the Hawaii State Department of Health (DOH) requires Puna Geothermal Venture (PGV) to develop a Casing Monitoring Program (CMP) regarding production and injection wells. This program is to be submitted to and approved by DOH prior to start of operation of injection wells drilled under permit UH-1529, for the PGV project site.

### 1.2 Purpose

The purpose of this CMP is to specify the observations, tests, drilling operations and, if necessary, remedial actions required to insure that the mechanical integrity of production and injection casing and cement is maintained throughout the drilling, testing and operation of PGV wells. The cemented and hung casing strings that are used in the PGV wells are designed to prevent contamination of any underground sources of drinking water (USDW) by either reservoir fluid in production wells or power plant effluent in injection wells. Contamination of the USDW's might occur if the casing strings are breached due to corrosion or mechanical failure or if there is a failure of the cement to seal the casing/borehole annulus above the zone of injection or production. The casing monitoring program described below is designed to detect and diagnose a loss of mechanical integrity in the casing or cement. Remedial actions required to restore mechanical integrity are also described.

## 1.3 Scope

This CMP covers all production and injection wells drilled by PGV and all existing wells that were drilled by previous operators on the 500 acre PGV site which to date have not been plugged and abandoned.

## 1.4 Hydrogeologic Basis for the Casing Monitoring Program

The hydrogeologic basis for the CMP is derived from data available from the drilling of five production wells to depths ranging from 6500' to 8000' and by two shallow monitoring wells drilled to depths of 640' and 720' (Figure 1).

1.4.1. The shallowest zone extending from surface (approximately 620' above sea level) to about 7' above mean sea level is unsaturated and consists of a highly permeable sequence of subareal basalt flows and interflow breccias. Within the project area this zone varies in thickness from 600' to 720' depending on the surface elevation. Numerous cracks with widths of up to 2' traverse the area. These cracks are vertical or very steeply dipping and reach from the surface to at least the top of the warm unconfined aquifer described below. This is evidenced by the discharge of warm moist air from many of these cracks. The cracks trend parallel to the major structures and lineaments of the Lower East Rift Zone.

1.4.2 The zone below the unsaturated surface rock consists of an unconfined aquifer which contains ground water with varying degrees of natural contamination from the underlying geothermal system. This zone is approximately 1400' thick with the water surface elevation controlled by sea level according to the Ghyben-Herzberg model. The unconfined aquifer surface in the project area is approximately 7' above mean sea level. Based on the model, the thickness of the low salinity lens is therefore about 280'. This constitutes the USDW. The salinity of the underlying water

will probably approach that of sea water. The temperature of the unconfined aquifer zone ranges from 95° to 192° F. in the project area and tends to be nearly isothermal throughout the entire interval, indicating good vertical mixing. A detailed description of this aquifer is given in the Puna Geothermal Venture Hydrologic Monitoring Program submitted to DOH in April 1990.

1.4.3. The interval from 1400' below sea level to 2400' below sea level (2000' to 3000' GL in Figure 2) is characterized by an extremely steep thermal gradient in the range of 30 F/100' or more. The steep temperature gradient is characteristic of conductive heat transfer and indicates the zone has essentially zero vertical permeability. Thus, the zone appears to be an effective aquitard separating the high temperature geothermal fluid below from the low temperature unconfined aquifer overlying it. Locally the aquitard exhibits natural leakage as in the area of MW-2 and GTW-III where anomalously high shallow ground water temperatures and salinities are observed.

1.4.4 Between the depths 2400' and 4300' below sea level (3000' to4900' GL in Figure 2) the temperature profile indicates the existence of a transition zone which consists of alternating permeable and impermeable strata. Within this zone are two or more alternating zones of high thermal gradients and isothermal intervals. The high average thermal gradient through this zone indicates that vertical fluid circulation is very limited.

1.4.5 Below a depth of about 4300' below sea level (4900' GL in Figure 2) the temperature profile becomes nearly isothermal. This interval is within the geothermal reservoir in which significant vertical movement of fluid is taking place at temperatures above 620 degrees F.

The casing program planned for the production and injection wells calls for cemented casing to reach from ground surface to a depth of about 3400' below sea level (Figures 3 and 4). This allows the casing to be anchored securely within the transition zone described in 1.4.4 and to fully isolate the geothermal reservoir from the shallow aquifer (lowermost USDW) with a cemented interval through the aquitard (1400'-2400' below sea level). Within the shallow aquifer zone,two cemented casing strings are installed. Three cemented casing strings pass through the top of the shallow aquifer and the unsaturated zone. The production and injection casing programs are designed to prevent leakage of geothermal fluid from the wellbore into the shallow aquifer above a depth of 1400' below sea level. The CMP discussed below provides the methods and procedures necessary to detect any leakage and to repair those leaks if detected.

## 2. PRODUCTION WELL CASING MONITORING PROGRAM

### 2.1 Pressure Testing During Drilling

Each production well is completed with three casing strings (not including the 30-inch conductor pipe) cemented to the surface (Figure 3). Immediately upon completion of cementing each casing string and prior to drilling out the cement shoe, the casing will be pressure tested. The test will consist of pressurizing the casing to a specified test pressure and holding for 30 minutes. The specified test pressure shall be the lesser of: (a) 2000 psig surface pressure or (b) 70% of the casing internal yield pressure less 250 psi at the shoe. (2000 psig is the maximum expected surface pressure on the 9-5/8" casing during production operations.) The pressure change during the 30 minute period shall not exceed 8%. The effect of the fluid expansion due to thermal recovery in the wellbore during the test period will be negligible throughout the test period.

In the event that excessive bleed-off occurs, one or more of the following diagnostic methods will be used to locate the leak:

- Temperature log while injecting
- Static temperature survey

integrity which is allowing cool water leakage into the wellbore.

Also during flow testing, TPS logs are periodically run. Leakage of cool water into the wellbore or loss of fluid to zones behind casing may be seen in the TPS logs run during or after shut-in. In the event that wellhead or logging data indicate a loss of mechanical integrity during the flow test, the well will be shut in and one or more of the following diagnostic methods will be used to confirm the leaks and locate it more precisely:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV

## 2.4 Monitoring During Production

Wellhead pressure and temperature will be monitored daily during normal production. Brine and steam chemistry will also be analyzed for each production well. Initially, samples will be taken weekly to establish a baseline geothermal fluid chemistry. The sampling frequency will then be reduced to monthly and quarterly as stabilization of the fluid chemistry is confirmed.

Casing failure causing leakage of cool ground water into the wellbore or loss of geothermal fluid to the formation may be manifested as a pressure and temperature drop at the wellhead. Fluid chemistry changes may also indicate ground water leakage. Wellhead pressure, temperature, and chemistry data will be reported to the DOH quarterly on a routine basis.

In the event that anomalous production parameters are observed, TPS survey(s) will be run with the well flowing. The TPS profiles will be used to determine whether the observed changes are due to changes in reservoir characteristics or are caused by a loss of mechanical integrity. In the event of a suspected loss of mechanical integrity, one or more of the following diagnostic methods will be used to confirm the leak and locate it more precisely:

## 3. INJECTION WELL CASING MONITORING PROGRAM

### 3.1 Pressure Testing During Drilling

The cemented casing string design in PGV injection wells (Figure 4) is similar to that of production wells. Testing of each string will proceed as described in 2.1 above.

### 3.2 Monitoring During Injection Testing

Prior to installation of the hangdown liner, an injection test will be performed to measure injectivity of the open formation below the cemented 9-5/8" casing. During the test, one or more of the following logs or surveys will be run:

- TPS through the open hole and cased intervals with the well on injection.
- Static temperature surveys to check for evidence of interformational flows behind casing.
- Other logs or surveys, as determined by PGV, to check for mechanical integrity of the casing and cement.

If the results of the logs and surveys confirm mechanical integrity, then the 7" hangdown liner may be installed. If leakage is found, repair procedures as described in 2.5 will be performed.

### 3.3 Monitoring During Routine Injection

During routine injection, the 7" x 9-5/8" annulus will be purged with nitrogen. Purge pressure and flow rate will be monitored for any changes indicative of a casing leak. Purge will be repeated as necessary to maintain the fluid level more than 1/2 way down the annulus. Once annually, tests and surveys will be conducted to verify mechanical integrity of the hangdown liner. The casing and hangdown liner will be tested for leaks by one of the following procedures, or a combination thereof:

3.3.1 Perform a pump-down test on the 7" x 9-5/8"

annulus. Nitrogen will be injected into the annulus to a pressure sufficient to displace the water level to the 9-5/8" casing shoe and shut in. Surface pressure on the annulus and hangdown liner will be monitored and recorded. Annulus pressure bleed-off exceeding 8% in 30 minutes will be considered indicative of a leak. If necessary, the pressure test will be extended beyond 30 minutes to preclude thermal effects on the surface pressure. In that case, the final 30 minutes will constitute the test period.

<u>or</u>

3.3.2 If the hangdown liner is pulled, the casing may be pressure tested above a bridge plug or packer set near the shoe following the basic procedure outlined in Section 2.1. Integrity of the hangdown liner may be verified by inspection on the surface, by a pressure test after it is run in the hole, or by a TPS log with the well on injection.

Integrity of the cement will be checked during each workover by one or more of the following procedures:

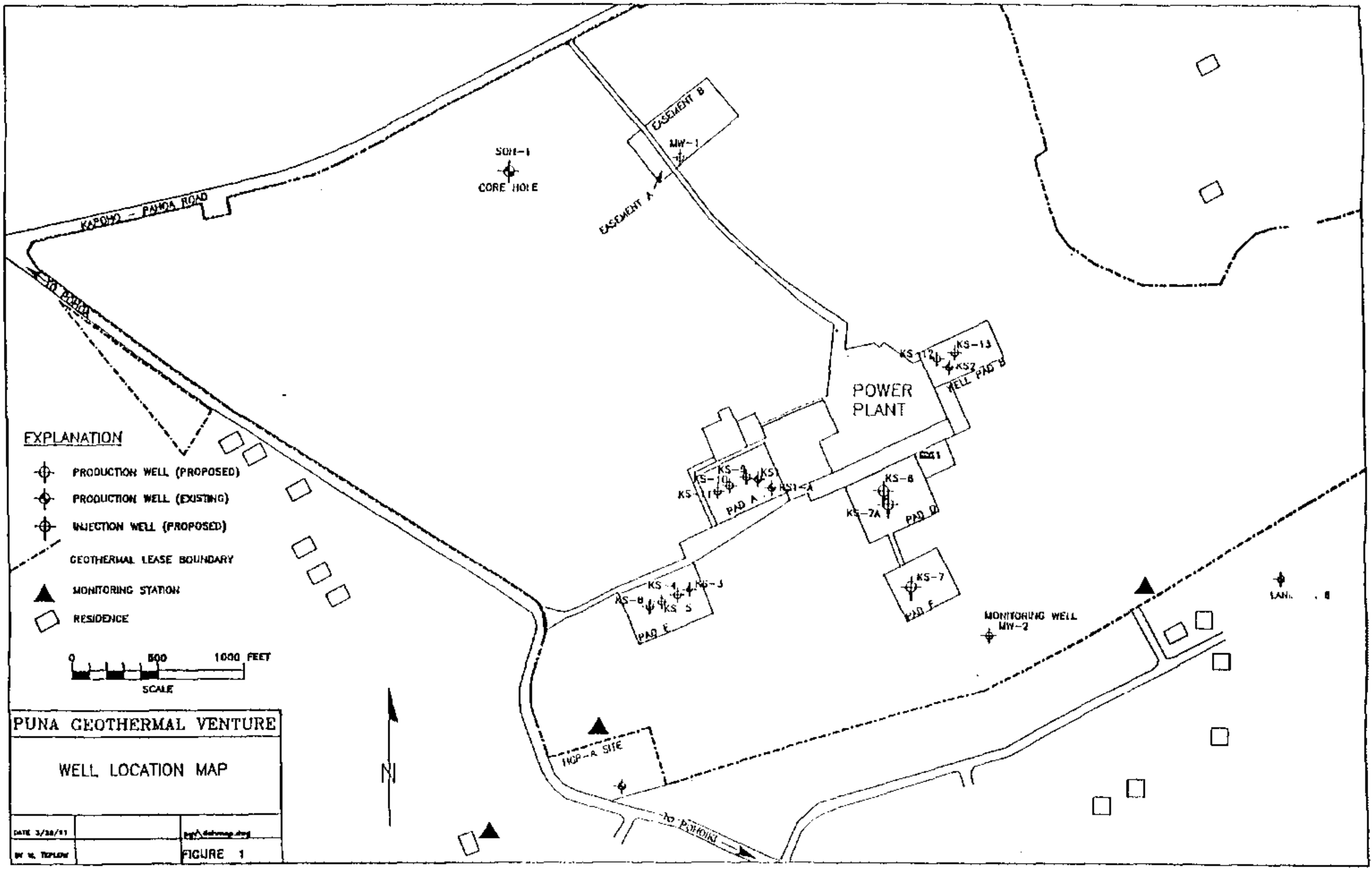
3.3.3 One or more shut-in static temperature surveys will be run. Shut-in time will be at least 12 hours, or longer if necessary to obtain meaningful results.

<u>or</u>

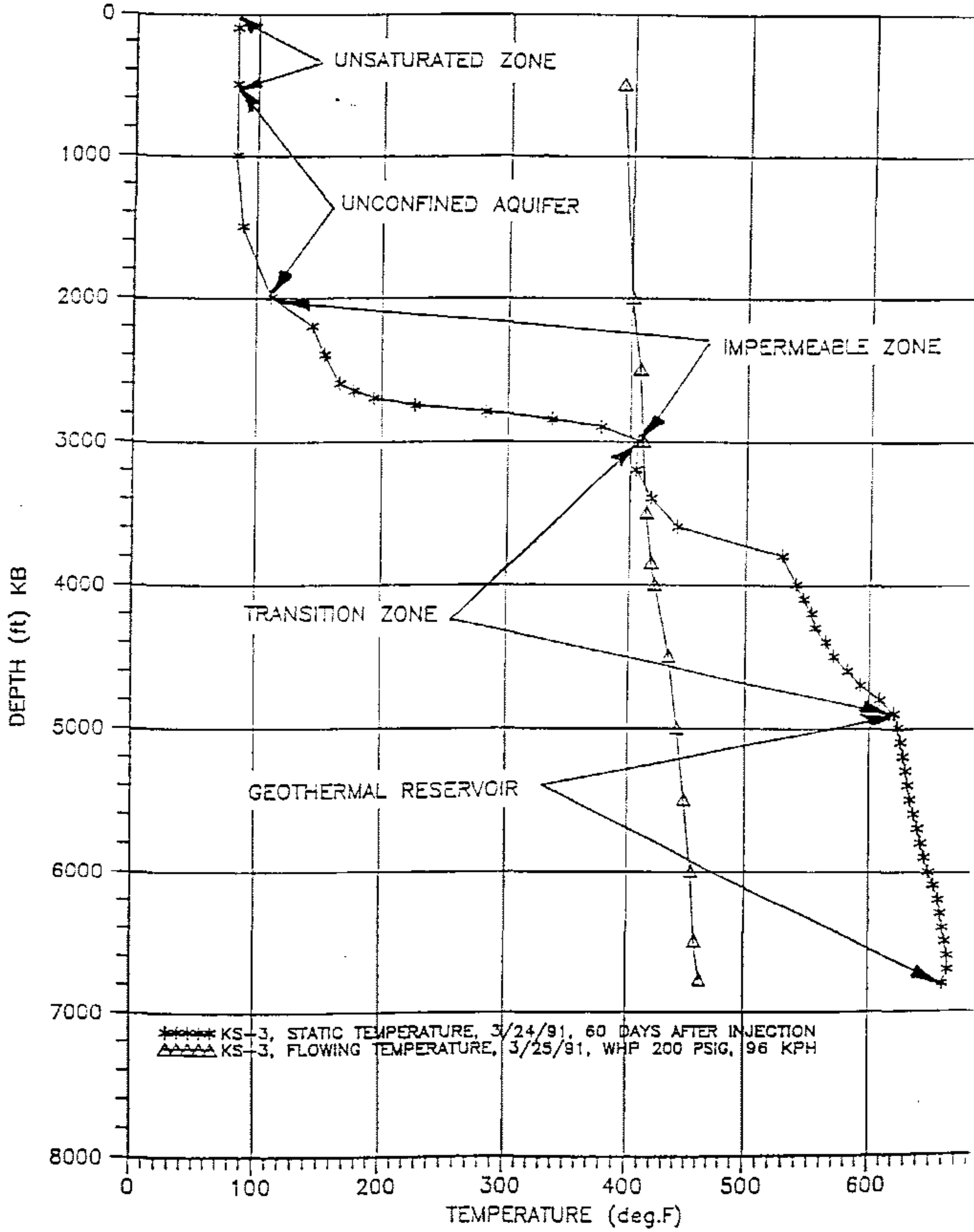
3.3.4 Other logs or surveys may be run, at the discretion of PGV, if static temperature surveys are not definitive.

### 3.4 Restoration of Mechanical Integrity or Abandonment

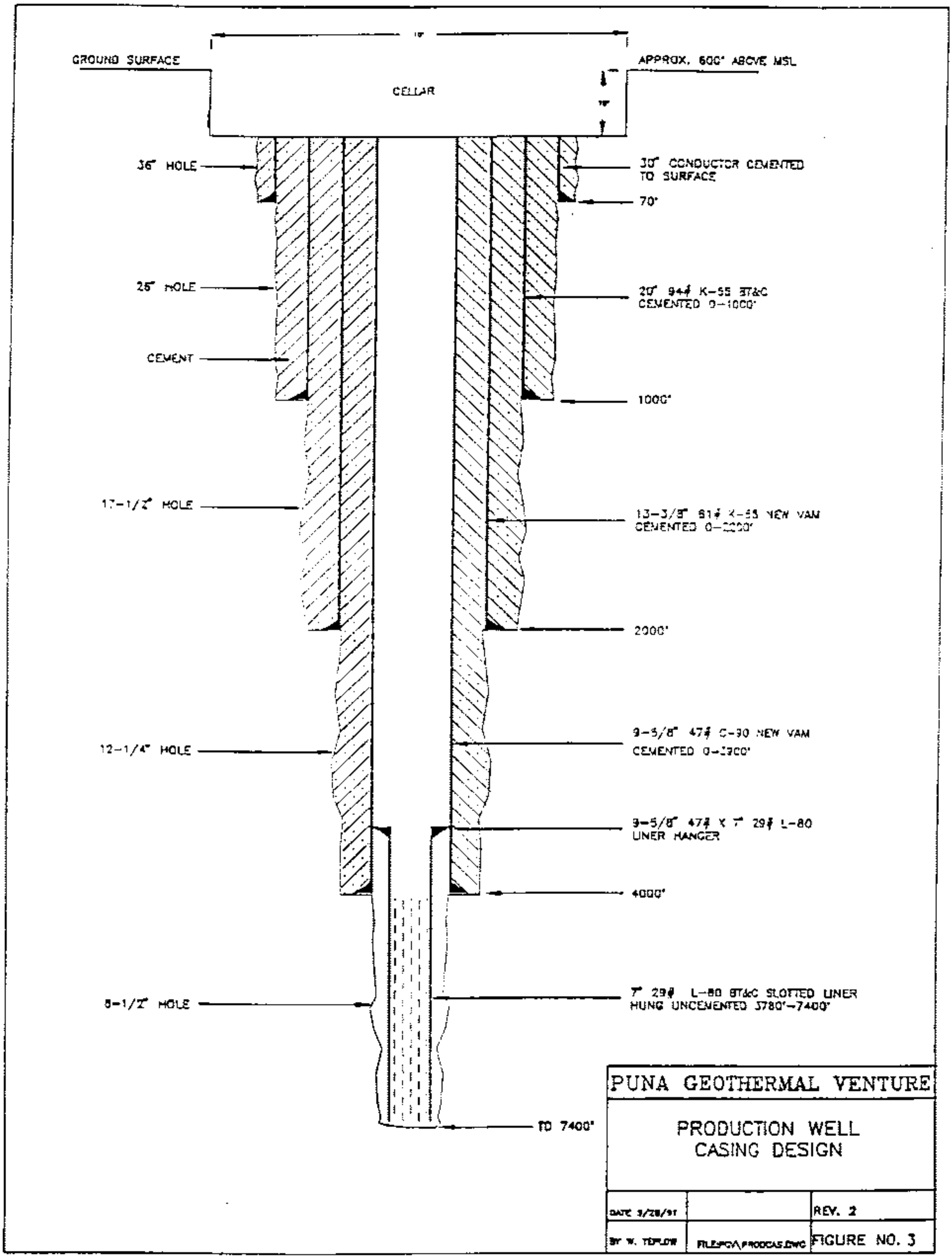
In the event that the diagnostic procedures indicate a loss of mechanical integrity, remedial or abandonment procedures will be carried out as specified in Section 2.5.


KAPOHO - PAHOA ROAD
SOH-1
CORE HOLE
EASEMENT B
MW-1
EASEMENT A
TO PAHOA
POWER PLANT
KS-13
WELL PAD B
KS-8
KS-7A
PAD D
KS-7
PAD F
PAD A
KS-4
KS-3
KS-5
PAD E
MONITORING WELL
MW-2
HGP-A SITE
TO POHOIKI
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
N
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
FIGURE 1

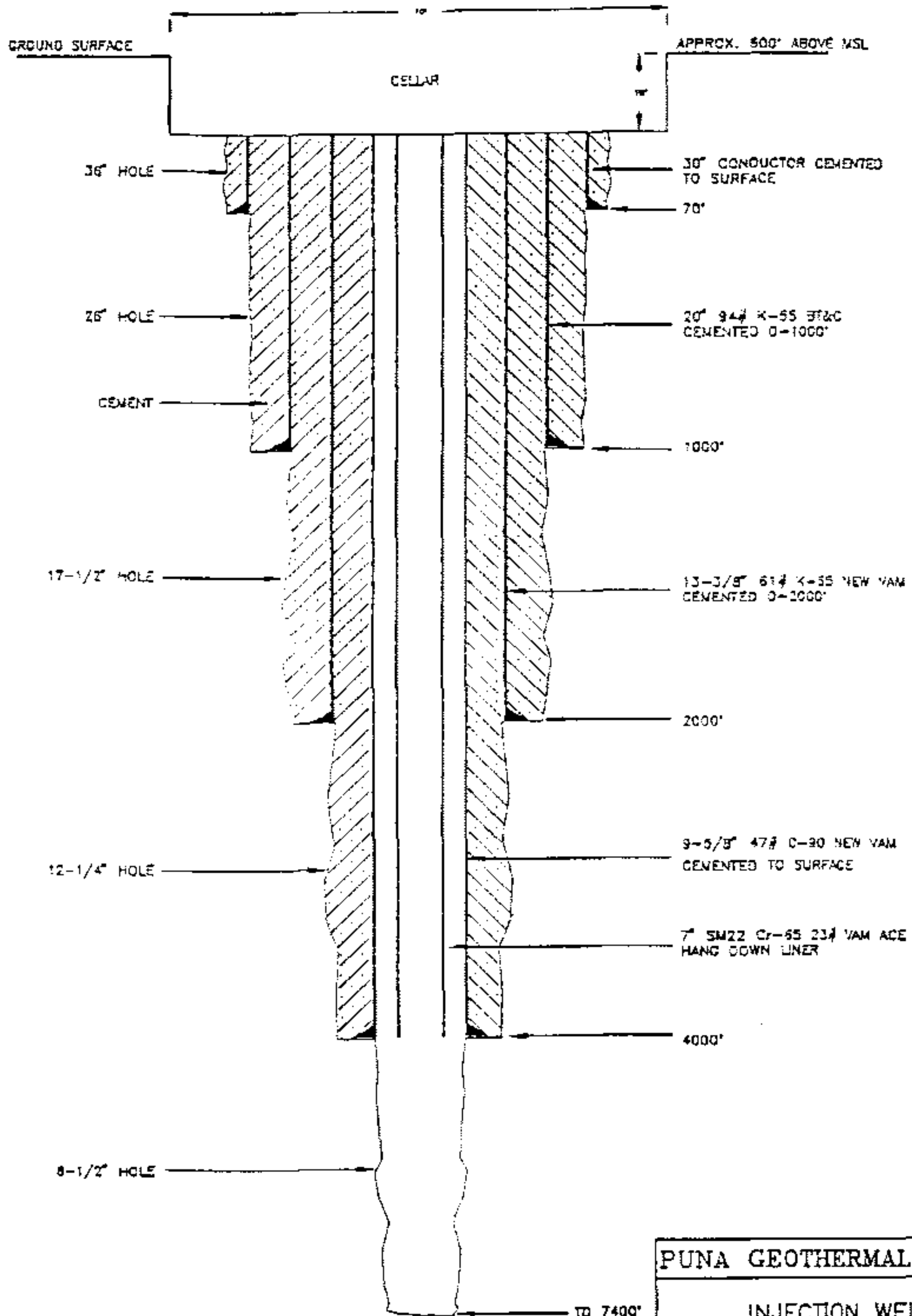
PUNA GEOTHERMAL VENTURE
KS 3 STATIC AND FLOWIN
TEMPERATURE PROFILES




FIGURE



GROUND SURFACE
APPROX. 600' ABOVE MSL
CELLAR
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# K-55 BT&C CEMENTED 0-1000'
CEMENT
1000'
17-1/2" HOLE
13-3/8" 61# K-55 NEW VAM CEMENTED 0-2000'
2000'
12-1/4" HOLE
9-5/8" 47# C-90 NEW VAM
CEMENTED 0-3900'
9-5/8" 47# X 7" 29# L-80 LINER HANGER
4000'
8-1/2" HOLE
7" 29# L-80 BT&C SLOTTED LINER HUNG UNCEMENTED 3780'-7400'
TD 7400'
PUNA GEOTHERMAL VENTURE
PRODUCTION WELL
CASING DESIGN
DATE 3/28/91
REV. 2
BY W. TEPLOW
FILE:PGV\PRODCAS.DWG
FIGURE NO. 3




PUNA GEOTHERMAL VENTURE

INJECTION WELL
CASING DESIGN

| | | |
|---|---|---|
| DATE 4/1/91 | File pgv\\[illegible] | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 4 |

EMK

# Harrison Engineers

Memorandum to: Bill Teplow, Zvi Reiss, Tom Kizis
From: Roger Harrison
Date: 2 April, 1992
Subject: **Report on Casing Inspection and 12 Hour Injection Test of KS-1A**

## 1. Summary

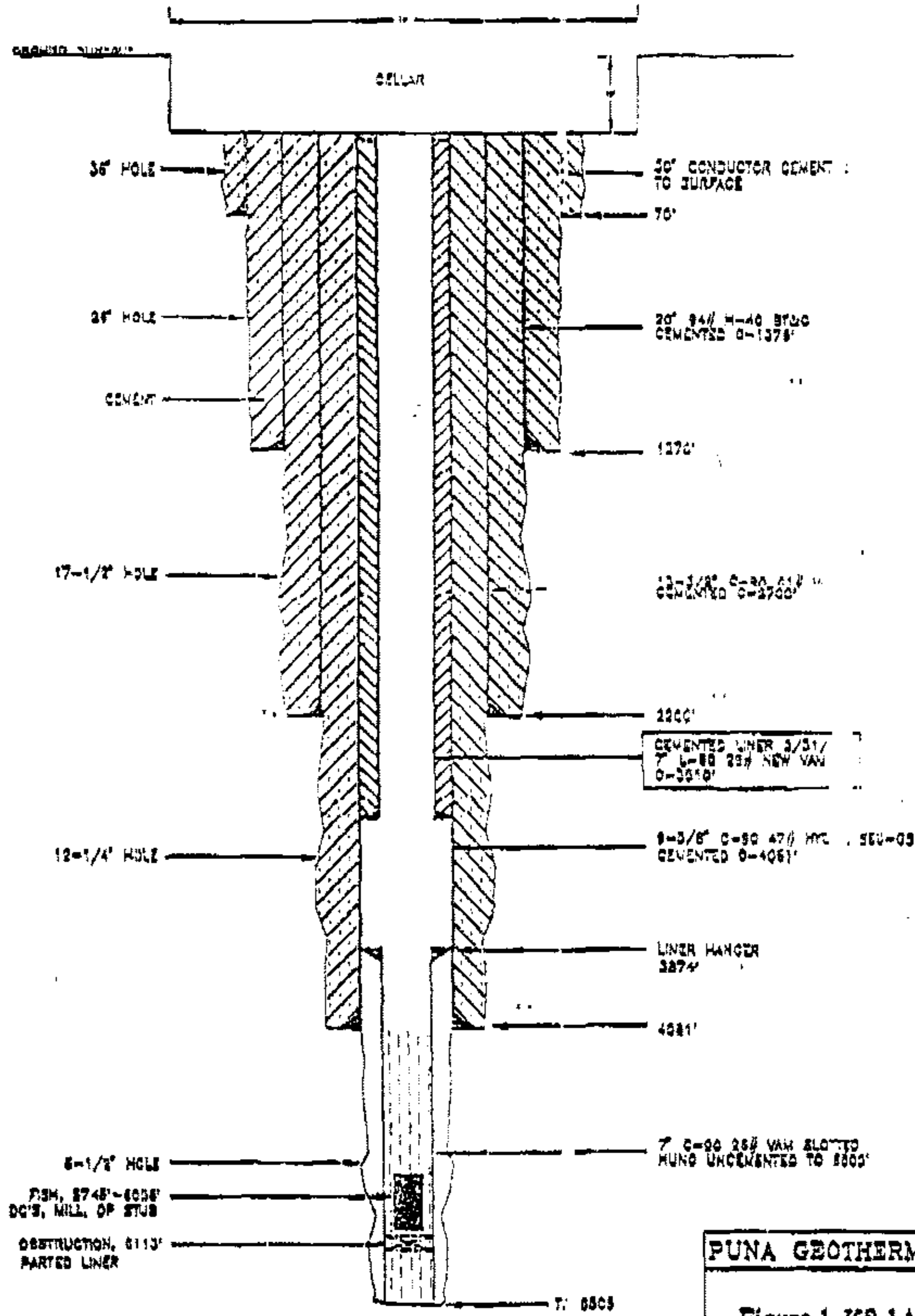
Casing inspection surveys and a 12 hour injection test were undertaken on KS-1A between March 14 and 20, 1992 in preparation for converting it to an injection well.

A four arm minimum inside diameter caliper and electromagnetic casing inspection (CIT) tool were run to ascertain the condition of the 7" cemented sleeve from 3510 feet to the surface. The surveys indicated the casing is in good condition with no evidence of scale or corrosion.

The injection test consisted of injecting fresh water supplied from the project site water wells for a continuous period of 12 hours. At the end of the test the well was taking 451 gpm at a wellhead pressure of 208 psi. The injectivity index derived from downhole pressure changes measured after the injection was shut-off was 0.8 gpm/psi.

The power plant injectate is expected to be at a temperature of 200°F. Using the injectivity determined from the test, the calculated injection capacity of the existing KS-1A completion when disposing power plant fluid is 400 gpm at the design wellhead pressure of 150 psi. Alternatively, the injection capacity is 370 gpm if a 5 1/2" liner is hung inside the 7" sleeve.

10 Landscape Road Epsom, Auckland Ph: 64 9 6386493 Fax: 64 9 6316530 New Zealand
1516 Oak Street, #311 Alameda, California 94501 USA




PUNA GEOTHERMAL VENTURE

Figure 1. KS-1A Completion

| | | |
|---|---|---|
| DATE 5/13/91 | | REV. 1 |
| BY W. TEPLOW | | |

## 2. Introduction

The well completion of KS-1A is shown in figure 1. A 7" sleeve was cemented inside the original 9 5/8" production casing from the surface to 3510 feet in 1991 in order to repair a damaged connection at 2910 feet and to facilitate rebuilding of the wellhead. The cemented 7" casing was inspected using Halliburton Logging Services instruments and logging equipment on March 14, 1992. A minimum ID log (4 arm caliper) was initially run from the bottom of the 7" sleeve at 3,510 feet to the surface. An electromagnetic casing inspection (CIT) survey was then run through the same interval.

A 12 hour injection test of KS-1A was conducted on 19 March, 1992. The test facilities are shown in figure 2 and comprised two Halliburton pumping units hooked in parallel through temporary piping to the permanent eight inch injection line to KS-1A. Water for the pumps was drawn from a 40,000 gallon Baker tank which was continuously recharged during the test by the two fresh water wells at the project site. The injected water temperature was 104°F. Flowrate was measured using an orifice type flowmeter installed a few feet upstream of the wellhead. Wellhead pressure was measured by a pressure gage installed on the three inch side outlet valve on the wellhead.

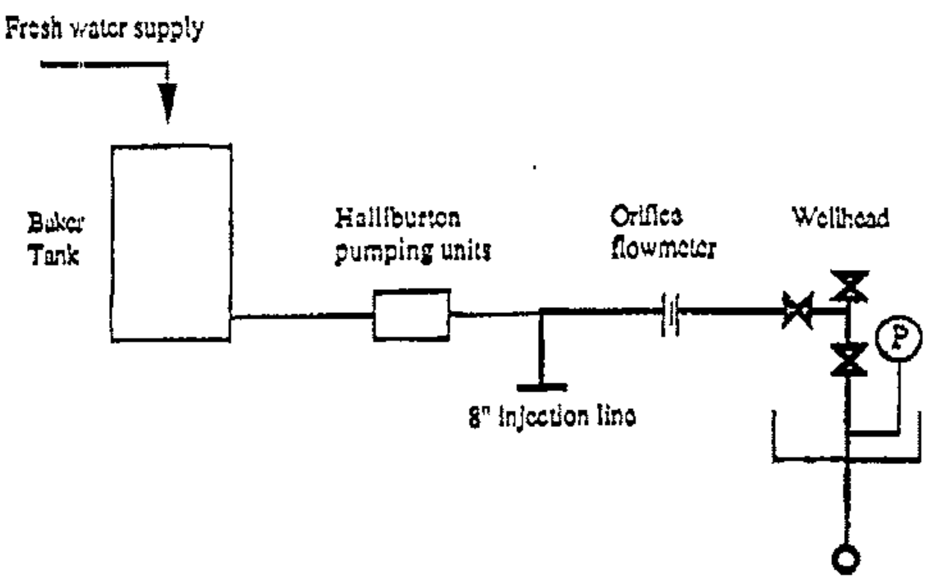



Figure 2. Injection Test Facilities

A number of downhole measurements were conducted during the test. A combination spinner - temperature survey was run in the cemented 7" sleeve during injection to check the mechanical integrity of the casing. Also, a pressure - temperature survey was run to 5,000 feet toward the end of the injection period. The instruments were subsequently suspended at 5,000 feet for 7 hours after injection was terminated to record pressure fall-off.

A further pressure - temperature survey was run on March 20, 1992, about 36 hours after the injection test.

## 3. Results

### 3.1 Casing Inspection

The minimum ID caliper and CIT inspection tools indicated the 7" sleeve was in good condition with no evidence of scale or corrosion.

### 3.2 Injection Test

The flowrate and wellhead pressure recorded during the test are presented in table 1 and figure 3. At the end of the 12 hour pumping period the flowrate was 450 gpm and the wellhead pressure was 208 psig.

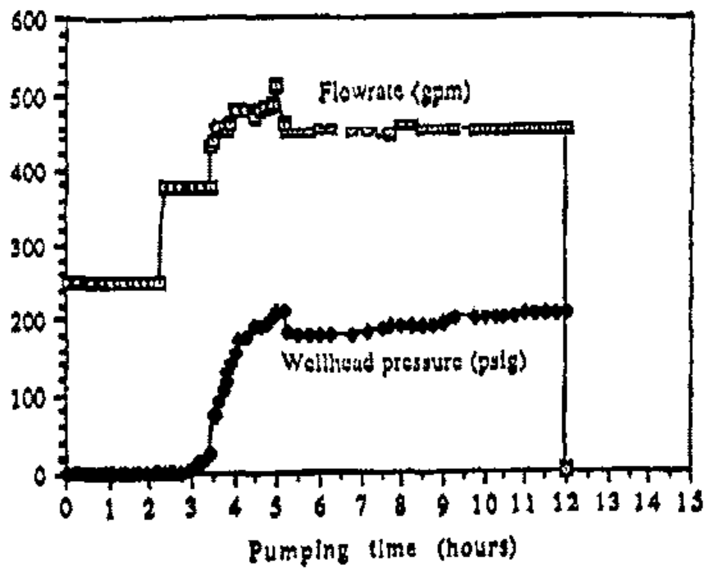



Figure 3. KS-1A 12 hour injection test, 18 March, 1992

Table 1. KS-1A 12 hour injection test data, 18 March, 1992

| Time 17-Mar-92 | Pumping Time (hrs) | Flowrate (gpm) | Wellhead Pressure (psig) | Injectivity Index (gpm/psi) | Comments |
|---|---|---|---|---|---|
| 07:45 | 0.00 | | 0 | | Start Pumping |
| 07:50 | 0.08 | 252 | 0 | | Inj. water temp = 104 F |
| 07:55 | 0.17 | 252 | 0 | | |
| 07:57 | 0.20 | 252 | 0 | | |
| 08:00 | 0.25 | 252 | 0 | | |
| 08:05 | 0.33 | 252 | 0 | | |
| 08:10 | 0.42 | 252 | 0 | | |
| 08:15 | 0.50 | 252 | 0 | | |
| 08:20 | 0.58 | 252 | 0 | | |
| 08:25 | 0.67 | 252 | 0 | | |
| 08:30 | 0.75 | 252 | 0 | | |
| 08:35 | 0.83 | 252 | 0 | | |
| 08:40 | 0.92 | 252 | 0 | | |
| 08:45 | 1.00 | 252 | 0 | | |
| 08:50 | 1.08 | 252 | 0 | | |
| 09:00 | 1.25 | 252 | 0 | | |
| 09:10 | 1.42 | 252 | 0 | | |
| 09:20 | 1.58 | 252 | 0 | | |
| 09:30 | 1.75 | 252 | 0 | | |
| 09:40 | 1.92 | 252 | 0 | | |
| 09:50 | 2.08 | 252 | 0 | | |
| 10:00 | 2.25 | 252 | 0 | | |
| 10:08 | 2.38 | 378 | 0 | | |
| 10:15 | 2.50 | 378 | 0 | | |
| 10:20 | 2.58 | 378 | 0 | | |
| 10:30 | 2.75 | 378 | 0 | | |
| 10:40 | 2.92 | 378 | 2 | | |
| 10:45 | 3.00 | 378 | 2 | | |
| 10:50 | 3.08 | 378 | 7 | | |
| 10:55 | 3.17 | 378 | 14 | | |
| 11:00 | 3.25 | 378 | 15 | 0.87 | |
| 11:10 | 3.42 | 378 | 25 | 0.85 | |
| 11:13 | 3.47 | 430 | | 1.03 | |
| 11:15 | 3.50 | 438 | 75 | 0.89 | |
| 11:20 | 3.58 | 460 | 75 | 0.93 | |
| 11:25 | 3.67 | 464 | 92 | 0.91 | |
| 11:30 | 3.75 | 453 | 105 | 0.86 | |
| 11:35 | 3.83 | 453 | 116 | 0.85 | |
| 11:36 | 3.85 | 453 | 130 | 0.83 | |
| 11:40 | 3.92 | 467 | 140 | 0.84 | |

Table 1. cont'd KS-3 12 hour injection test

| Time 17-Mar-92 | Pumping Time (hrs) | Flowrate (gpm) | Wellhead Pressure (psig) | Injectivity Index (gpm/psi) | Comments |
|---|---|---|---|---|---|
| 13:00 | 5.25 | 452 | 185 | 0.75 | |
| 13:15 | 5.50 | 452 | 180 | 0.75 | |
| 13:30 | 5.75 | 452 | 180 | 0.75 | |
| 13:45 | 6.00 | 456 | 180 | 0.76 | |
| 14:00 | 6.25 | 456 | 180 | 0.76 | |
| 14:03 | 6.30 | | | | Start Spinner Survey |
| 14:23 | 6.63 | 453 | 180 | 0.76 | |
| 14:30 | 6.75 | 453 | 180 | 0.76 | |
| 14:54 | 7.15 | 453 | 185 | 0.75 | |
| 15:15 | 7.50 | 449 | 187 | 0.74 | |
| 15:30 | 7.75 | 445 | 190 | 0.73 | |
| 15:45 | 8.00 | 458 | 190 | 0.75 | |
| 16:00 | 8.25 | 458 | 190 | 0.75 | |
| 16:15 | 8.50 | 453 | 190 | 0.74 | |
| 16:30 | 8.75 | 451 | 190 | 0.74 | |
| 16:45 | 9.00 | 451 | 195 | 0.73 | |
| 17:00 | 9.25 | 451 | 200 | 0.73 | |
| 17:30 | 9.75 | 453 | 200 | 0.73 | |
| 17:45 | 10.00 | 453 | 200 | 0.73 | |
| 18:00 | 10.25 | 453 | 200 | 0.73 | |
| 18:15 | 10.50 | 453 | 200 | 0.73 | |
| 18:30 | 10.75 | 453 | 200 | 0.73 | |
| 18:45 | 11.00 | 453 | 205 | 0.73 | |
| 19:00 | 11.25 | 453 | 205 | 0.73 | |
| 19:15 | 11.50 | 453 | 205 | 0.73 | |
| 19:30 | 11.75 | 453 | 205 | 0.73 | |
| 19:45 | 12.00 | 453 | 205 | 0.73 | |
| 19:46 | 12.02 | 0 | | | Shut-in |

The results of the spinner - temperature survey are presented in table 2. The spinner survey showed a small quantity of flow was lost between 2,000 and 3,000 feet. The change is within the measurement accuracy of the instrument. Since no signs of casing damage were evident on the casing inspection surveys it is concluded that the casing is sound. (Note: the temperature measured by the downhole instruments is about 40°F lower than the actual injected water temperature. This is because the instruments are designed primarily to measure high temperatures and are not accurate when measuring low temperatures.)

Table 2. Spinner - temperature survey while injecting

| Depth (feet) | Temperature (F) | Spinner % of flow |
|---|---|---|
| 1000 | 64 | 100 |
| 2000 | 68 | 100 |
| 3000 | 70 | 91 |
| 3420 | 71 | 91 |

The results of the pressure - temperature survey conducted while injecting are given in table 3 and the pressure fall-off data is given in table 4.

Table 3. Pressure - temperature survey while injecting

| Depth (feet) | Temperature (F) | Pressure (psig) |
|---|---|---|
| 1000 | 65 | 611 |
| 2000 | 69 | 1038 |
| 3000 | 70 | 1461 |
| 4000 | 73 | 1877 |
| 5000 | 80 | 2305 |

Table 4. Pressure fall-off (at 5,000 feet) after injection

| Time (minutes) | Pressure (psig) | Temperature (F) |
|---|---|---|
| 0 | 2305 | 80 |
| 10 | 2205 | 90 |
| 20 | 2133 | 95 |
| 30 | 2092 | 100 |
| 90 | 1955 | 116 |
| 150 | 1896 | 127 |
| 210 | 1868 | 136 |
| 270 | 1846 | 141 |
| 330 | 1836 | 147 |
| 390 | 1827 | 154 |
| 450 | | 160 |
| 500 | 1014 | 171 |

The pressure and temperature changes at 5,000 feet are plotted in figure 4.

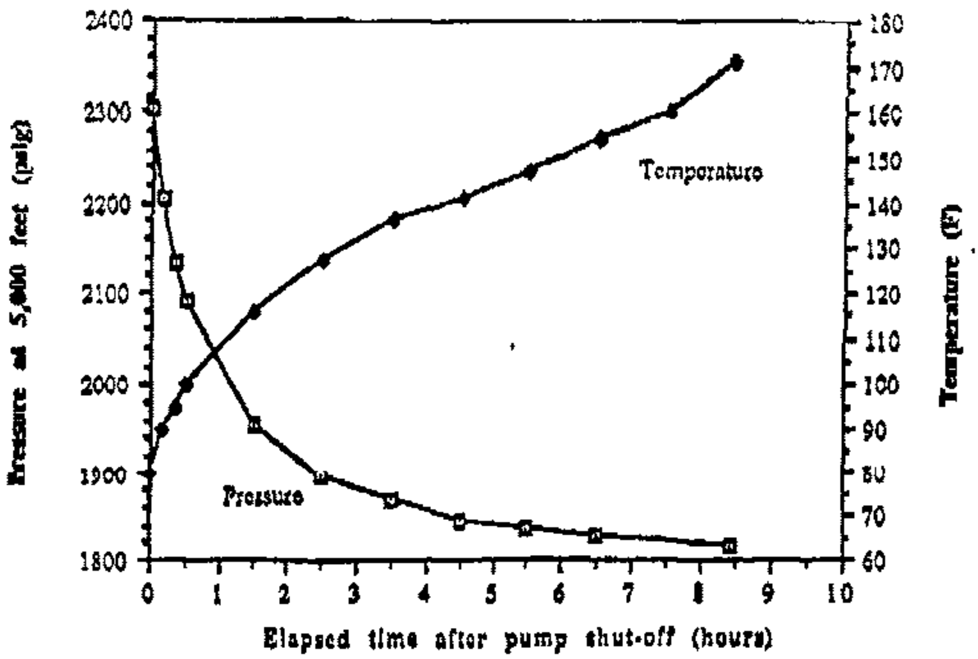



Figure 4. Pressure and Temperature changes at 5,000 feet after pump shut-off

A Horner plot of the pressure fall-off data is shown in figure 5. The calculated flow capacity is 14,800 md-ft/cp which indicates the reservoir in the vicinity of KS-1A has low permeability.

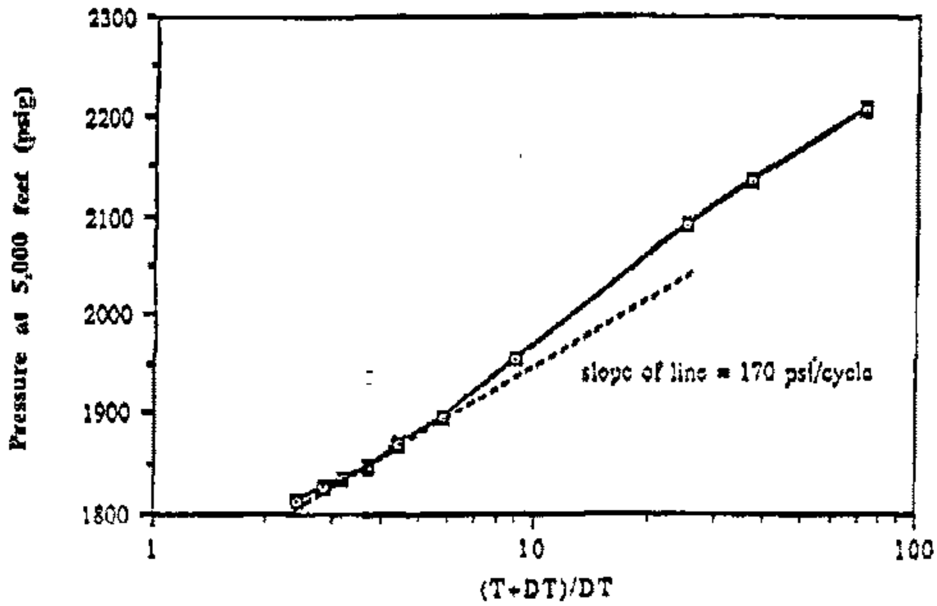



Figure 5. Horner plot of fall-off data

The pressure and temperature survey conducted on March 20, 1992, approximately 36 hours after the injection test is presented in table 5.

Table 5. Static pressure - temperature survey 20 March, 1992, 1 day after injection test

| Depth (feet) | Temperature (F) | Pressure (psig) |
|---|---|---|
| 500 | 62 | |
| 1000 | 57 | 136 |
| 1500 | 78 | 348 |
| 2000 | 108 | 566 |
| 2500 | 112 | 781 |
| 3000 | 179 | 985 |
| 3200 | 233 | 1060 |
| 3400 | 268 | 1137 |
| 3600 | 295 | 1778 |
| 3800 | 318 | 1309 |
| 4000 | 321 | 1389 |
| 4200 | 322 | 1430 |
| 4400 | 322 | 1502 |
| 4600 | 322 | 1578 |
| 4800 | 311 | 1650 |
| 5000 | 277 | 1722 |

The temperature data is plotted on figure 7. The survey exhibits a temperature reversal below 4600 feet. This indicates most of the injected water was leaving the well below this depth.

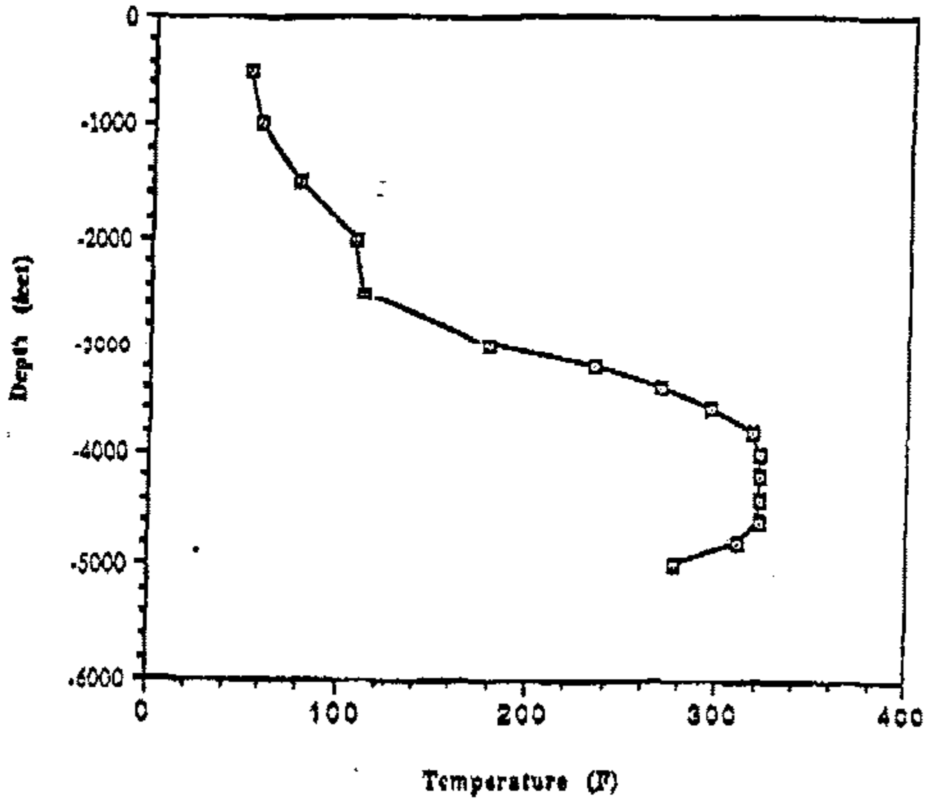



Figure 7. Static pressure - temperature survey, 20 March,1992 - 1 day after injection

The measured pressure at 5,000 feet on March 20 was 1722 psig. The total pressure change at 5,000 feet over the 36 hours or so between shutting-off injection and the March 20 survey was therefore; 2305 - 1722 = 583 psi. The injectivity index given by this is; 451 gpm / 583 psi = 0.8 gpm/psi. The injectivity index calculated for the portion of the test during which the well exhibited a positive wellhead pressure is on table 1.

4. **Injection Capacity when Disposing of Power Plant Fluids**

The injection capacity (Q) can be expressed as follows:

$$Q = II * [ WHP + WD * \rho / 144 - SP - FP ]$$

where; Q = injection flowrate (gpm)
II = injectivty index (gpm/psi)
WHP = wellhead pressure (psig)
WD = well depth to injection zone (ft)
$\rho$ = density of injection fluid (lb/ft$^3$)
SP = static pressure at injection zone (psig)
FP = wellbore friction pressure drop of fluid being injected (psi)

The power plant injection fluids will be single phase liquid (noncondensible gases will be in solution at the injection pressure) at a temperature of 200°F. In the case of KS-1A, the measured injectivity index (II) is 0.8 gpm/psi, the design injection wellhead pressure (WHP) is 150 psig, the well depth to the injection zone (WD) is assumed to be 5,000 feet, the injection fluid density ($\rho$) is 60.1 lb/ft$^3$ and the static pressure at the injection zone (SP) is 1722 psig. For the conditions relevant to this case the friction pressure drop can be expressed as follows;

$$FP = 0.91 * Q^2 / d^5$$

where d = effective internal diameter (inches)

For the existing completion (effective internal diameter approximately 6.6"), the calculated injection capacity of KS-3 is 400 gpm. For a completion with a 5 1/2" liner hung from the surface to 3,510 feet (effective internal diameter approximately 5.2") the injection capacity is 370 gpm.

FLC  CONTROL & MINERAL RESOURCE BRA  H

6/92

Division of Water and Land Development

FROM: J. Ekern  DATE: ____________ FILE IN: KS-1A

| TO: | INITIAL: | | PLEASE: | REMARKS: |
|---|---|---|---|---|
| ___ | ___ | G. AKITA | ___ See Me | Please file in KS-1A |
| ___ | ___ | L. Choo | ___ Call | |
| | | | ___ Review & Comment | |
| ___ | ___ | T. Kam | ___ Take Action | |
| ___ | ___ | H. Young | ___ Investigate & Report | |
| ___ | ___ | S. Yong | ___ Draft Reply | |
| ___ | ___ | C.P. Chang | ___ Acknowledge Receipt | |
| ___ | ___ | Y.F. Xu | ___ Type Draft | |
| ___ | ___ | T. Nakama | ___ Type Final | |
| ___ | ___ | J. Swift | ___ Xerox ___ copies | |
| ___ | ___ | J. Florez | ___________ | |
| ___ | ___ | M. Tanouye | | |
| X | ___ | C. D'Araujo | | |
| | | | FOR YOUR: | |
| ___ | ___ | M. TAGOMORI | | |
| ___ | ___ | L. Nanbu | ___ Approval | |
| ___ | ___ | L. CHANG | ___ Signature | |
| ___ | ___ | E. LAU | ___ Information | |
| ___ | ___ | A. Monden | X File | |
| ___ | ___ | G. Miyashiro | | |
| ___ | ___ | D. Lee | REQUESTED BY: | |
| ___ | ___ | ___________ | | |
| ___ | ___ | ___________ | ___________ | |
| | | | DATE | |

# ENGINEERING AND GEOLOGIC REPORT FOR INJECTION WELL KAPOHO STATE 1A

1. General Information
   a. Well Designation: Kapoho State 1A
      Location: TMK 1-4-01:02, Kapoho, Puna, Hawaii
      (see Figure 1)
      Leased to: Kapoho Land Partnership
      Subleased to: Puna Geothermal Venture
      Operator: AMOR VIII Corporation

   b. Well Kapoho State 1A, located on Pad A (see Figure 2), was drilled in 1985, the third geothermal well drilled by Thermal Power Corporation. The well was worked over and the casing modified by Puna Geothermal Venture in 1991. The locations of other existing wells and planned wells are shown on Figure 3. Elevation of the wellhead is 618 ft above sea level.

2. Physical Characteristics of the Area
   a. The Puna Geothermal Venture Project is a 500-acre lease located in the Puna District of the County of Hawaii, approximately 21 miles southeast of the city of Hilo, in the Kapoho section of the Kilauea Lower East Rift Geothermal Resource subzone (see Figure 4).

   b. The project area lies on the windward side of the Big Island of Hawaii and receives 100 to 150 inches of rain per year. Daytime winds are generally Trades blowing from the northeast, at 10 - 30 miles per hour, and nighttime winds blow from the northwest at slightly diminished speeds.

   c. The wellfield and power plant are located on the southern flank of Puu Honuaula, a cinder cone with an elevation of 860 ft. The topography to the south-southeast of the puu has a moderate slope of approximately 10° (15 ft/100 ft) with some minor undulations. The wellfield to the southwest of the puu is generally flat with an average elevation of about 610 ft.

   d. Pad A was constructed on basalt flows from the 1955 eruption. The original surface was grubbed and a platform of compacted fill, consisting of rock and cinder was constructed.

   e. Earthquake and volcanic hazard risks are high in the East Rift Zone. Seismic and volcanic risk assessment reports were prepared for the project. Power plant structures conform with Seismic Zone 4 requirements and the brine injection pipelines were designed with expansion loops which will minimize the effects of fissuring, subsidence and ground swelling. The cellar of KS-1A was specially designed to be readily filled with volcanic cinders in order to reduce the chances of structural failure in the event of a lava flow.

f. Flood problems are not anticipated in the project area due to the highly porous nature of the surface basalt flows.

g. For information confirming conformance with local land use planning and zoning regulations, see Appendix I.

3. Description of System Operation

a. All geothermal fluids produced during operation of the PRG Project wellfield and power plant, including geothermal brine, geothermal steam condensate and geothermal noncondensible gases, will be injected back into the geothermal reservoir. Geothermal reservoir fluids will be produced typically from depths greater than 4000 ft and reinjected at equivalent depths.

The fluid from the production wells will be sent through a separator which will separate the steam from the residual brine. The brine will be directed to the injection facility and the steam will be directed towards the power plant. Within the environs of the power plant, the steam will pass through steam turbines and then low pressure OEC vaporizers. The by-products of the power generation system are steam condensate and noncondensible gases. These three components, the separated brine, steam condensate and noncondensible gases, will be recombined prior to injection in order to produce a fluid with the same composition as the original geothermal fluid.

Table 1 shows the anticipated range of geothermal brine and steam condensate chemistries as described in the Puna Geothermal Venture GRP application. Table 2 compares brine analyses from KS-1A and KS-3 with shallow ground water analyses from nearby PGV monitor wells and Puna District water supply wells (Pahoa and Kapoho/Green Lake).

The anticipated range of noncondensible gas chemistries, modified from the PGV GRP application is presented in

Table 3; Representative noncondensible gas analyses from KS-3 and KS-1A have been added.

b. The 25 MW Net power plant is designed to run on approximately 505,000 lb/hr of steam derived from an original geothermal fluid that will separate into 35% to 60% steam and 65% to 40% brine. Anticipated mass flow rates of injectate are as follows:

| | Estimated normal rates based on 60% flash (lb/hr) | Estimated maximum rates (lb/hr) |
|---|---|---|
| Condensate | 505,816 | 505,816 |
| Brine | 337,211 | 939,373 |
| Supplemental water and/or brine from storage pits | 0 | 144,516 |
| Total NCG | 1,573 | 2,696 |
| Total Flow | 844,600 | 1,592,404 |

c. The injection system (see Figure 5) consists of four components: (1) a brine accumulator and brine injection pump; (2) a noncondensible gas compressor, noncondensible gas system condensate pump and a noncondensible gas injection pump; (3) a condensate accumulator, condensate pump, and condensate injection pump; and (4) a water injection pump, necessary to maintain fluid volume if any OEC's are taken off-line. Each component of the system will be backed by spare fluid pumps. A spare noncondensible gas compressor and a spare geothermal injection well will also be provided.

In the event of an upset in the injection system, the injectate will be discharged into an unlined holding pond at the power plant site constructed to receive and temporarily store the geothermal brine and/or condensate. Prior to discharge into the holding pond, the brine will pass through an emergency steam release facility.

The steam release facility will consist of two rock mufflers. Each rock muffler is designed to dissipate the steam's acoustic energy, thereby reducing the noise associated with steam release. Each muffler is designed to handle 570,000 lb/hr of steam, which is 100% of the maximum total plant steam flow. Prior to entering the

the $H_2S$ entrained in the steam. Removal of 96% of the $H_2S$ is anticipated from the caustic treatment system.

d. Three injection wells are planned to serve four to five production wells. KS-1A and KS-3 have been designated as injection wells.

Estimated normal and maximum injection rates for the project are given in Section 3b.

f. The injection well will be utilized 24 hours per day.

g. No treatment of the steam or brine is planned under normal power plant operating conditions.

4. Geohydrologic Considerations

a. KS-1A is located on Pad A. Wellhead coordinates are 19°28.79' North Latitude and 154°53.60' West Longitude. Ground elevation is 618 ft above sea level.

b. The lithology of KS-1A is summarized in Table 4. The formation consists wholly of tholeiitic basalts and differentiated tholeiitic basalts deposited as extrusive flows which have been cross cut by differentiated tholeiitic intrusive dikes. The extrusive basalts can be subdivided into three units based on recognizable textural characteristics induced by their depositional environment. These units are subaerial aa and pahoehoe flows, submarine pillow basalts and a transitional unit consisting of hyaloclastites intercalated with subordinate volumes of pillow basalts and subaerial flows. The frequency of intrusive dikes increases with depth. Dikes are extremely rare in the upper 2000 ft of KS-1A but are the dominant rock type below 5140 ft.

The 9⅝-in. casing shoe was set at 4061 ft KB and demarcates the open hole interval. As noted in Figure 6, the rig KB reference is 18 ft above ground level. The formation encountered in the open section of the hole consists of two rock types, pillow basalts and intrusive dikes. From drilling rates and examination of the core from SOH 1, the dikes are basically unaltered and non-fractured and behave as localized aquitards. The pillow basalts are in part brecciated. Pillow breccias display varying degrees of hydrothermal alteration and vug mineralization.

The static water table was encountered at approximately 603 ft KB.

c. A chemical analysis of the groundwater collected while drilling is unavailable. A chemical analysis of groundwater sampled from monitor well MW-2, located 1500 ft southeast of KS-1a, is found in Table 2 .

d. Thermal Power Corporation conducted an injection test of KS-1A in December of 1985 in order to quantitatively evaluate the formation permeability below the shoe at 4061 ft. The results of the test indicated an injectivity index of 2.2 gpm/psi. Pressure fall-off data were inconclusive.

Casing inspection surveys and a 12-hour injection test were conducted by Puna Geothermal Venture between March 14 and 20, 1992 in preparation for converting KS-1A to an injection well. The results of this test program are attached as Appendix II. The pertinent data are summarized below.

At the end of the injection test the well was taking 451 gpm at a wellhead pressure of 208 psi (see Figure 3 of Appendix II). The associated injectivity index was calculated at 0.8 gpm/psi. Based on the expected chemical characteristics of the power plant injection fluids, fluid temperatures of 200°F and an applied wellhead pressure of 150 psi, the calculated injection capacity of KS-1A is 400 gpm.

Review of the temperature-pressure-spinner survey run during the flow test (see Table 2 of Appendix II and the static pressure-temperature survey run one day after injection (see Figure 7 of Appendix II) indicates that essentially all the water is exiting the wellbore below 4600 ft.

Calculated flow capacity of KS-1A, based on a Horner plot of the fall-off data (see Figure 5 of Appendix II), is 14,800 md-ft/cp.

e. KS-3 is also an injection well.

f. The casing schematic and descriptions of materials are attached as Figure 6. A fish, consisting of approximately 311 ft of drillpipe, drill collars and a mill was left in the hole between 5745 ft and 6056 ft.

William J. Teplow

William Teplow, Geologist

REGISTERED GEOLOGIST

WILLIAM J. TEPLOW

No. 4521

STATE OF CALIFORNIA

4/7/92

Date

Robert V. Verity

Robert Verity, Petroleum Engineer

April 7, 1992

Date

REGISTERED PROFESSIONAL ENGINEER

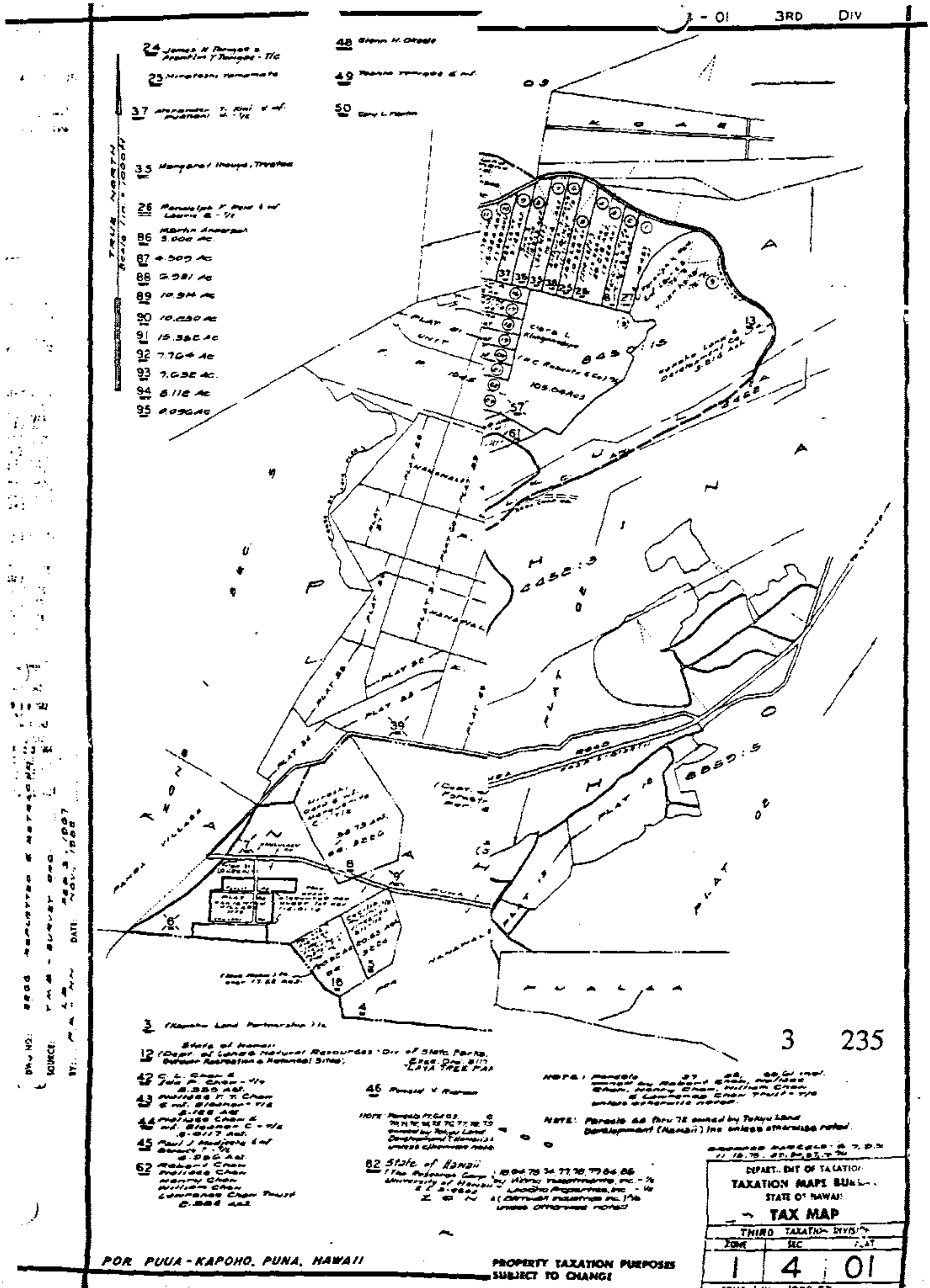
ROBERT V. VERITY

NO.
P 001606
exp. 9/30/95

PETROLEUM

STATE OF CALIFORNIA

FIGURE 1


3RD DIV
3 235
DEPARTMENT OF TAXATION
TAXATION MAPS BUREAU
STATE OF HAWAII
TAX MAP
THIRD TAXATION DIVISION
ZONE SEC PLAT
1 4 01
SCALE: 1 IN. = 1000 FT.
POR. PUUA - KAPOHO, PUNA, HAWAII
PROPERTY TAXATION PURPOSES
SUBJECT TO CHANGE

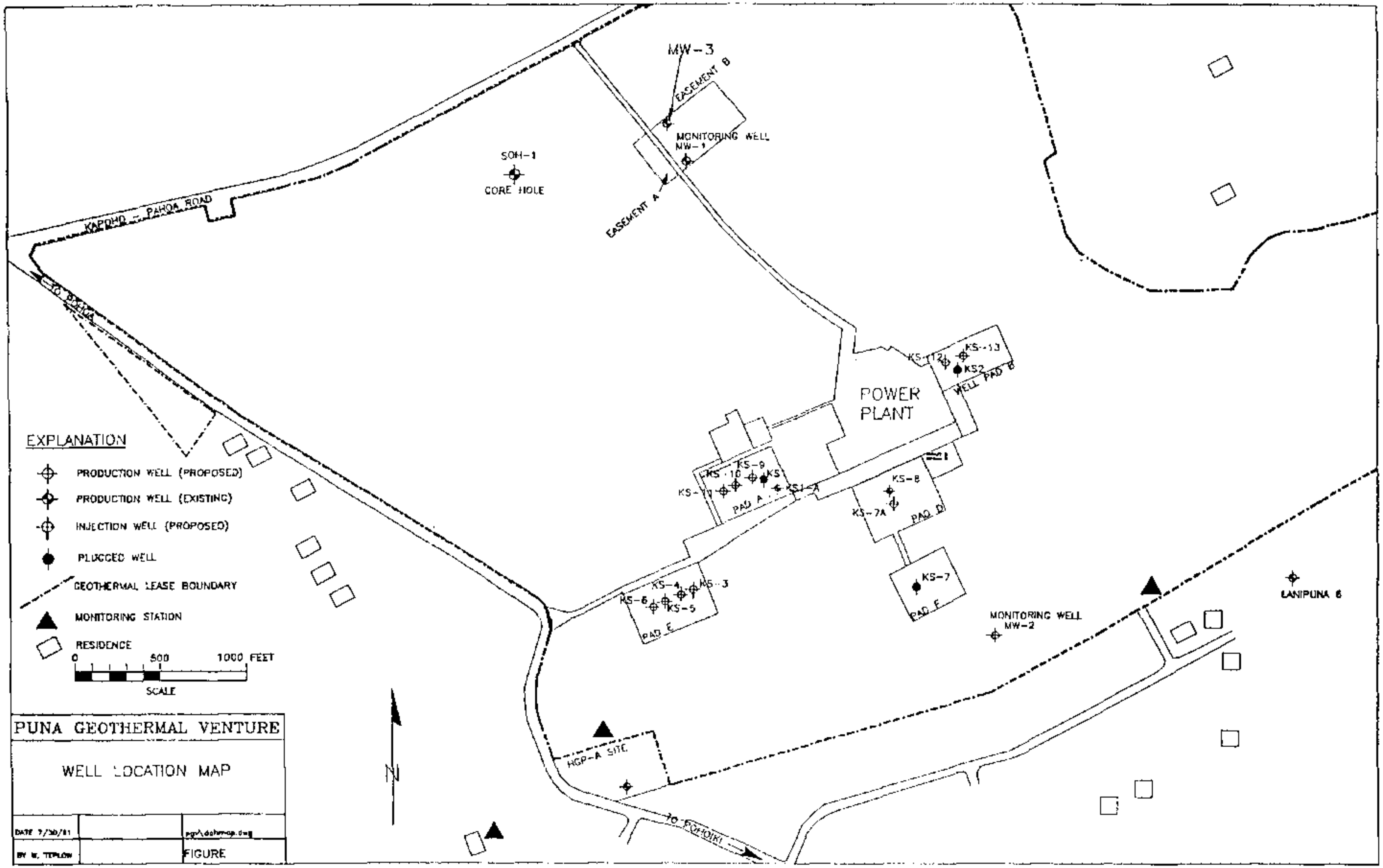
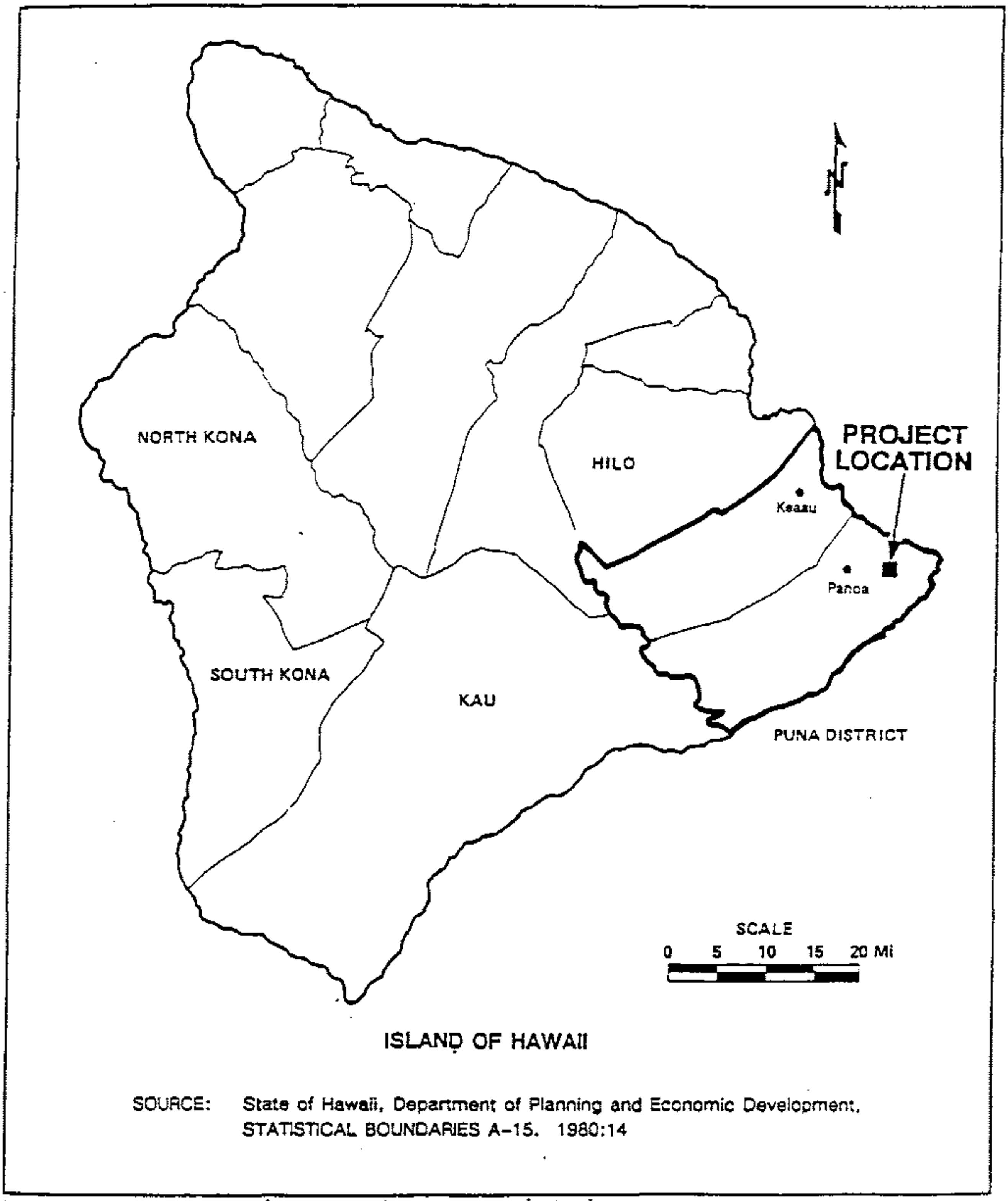

MW-3
EASEMENT B
MONITORING WELL
MW-1
SOH-1
CORE HOLE
EASEMENT A
KAPOHO - PAHOA ROAD
TO PAHOA
POWER
PLANT
KS-12
KS-13
KS2
WELL PAD B
KS-9
KS-10
KS1
KS-11
KS1-A
PAD A
KS-8
KS-7A
PAD D
KS-7
PAD F
KS-4
KS-3
KS-6
KS-5
PAD E
MONITORING WELL
MW-2
LANIPUNA 6
HGP-A SITE
TO POHOIKI
N
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
PLUGGED WELL
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 7/30/91
BY W. TEPLOW
FIGURE

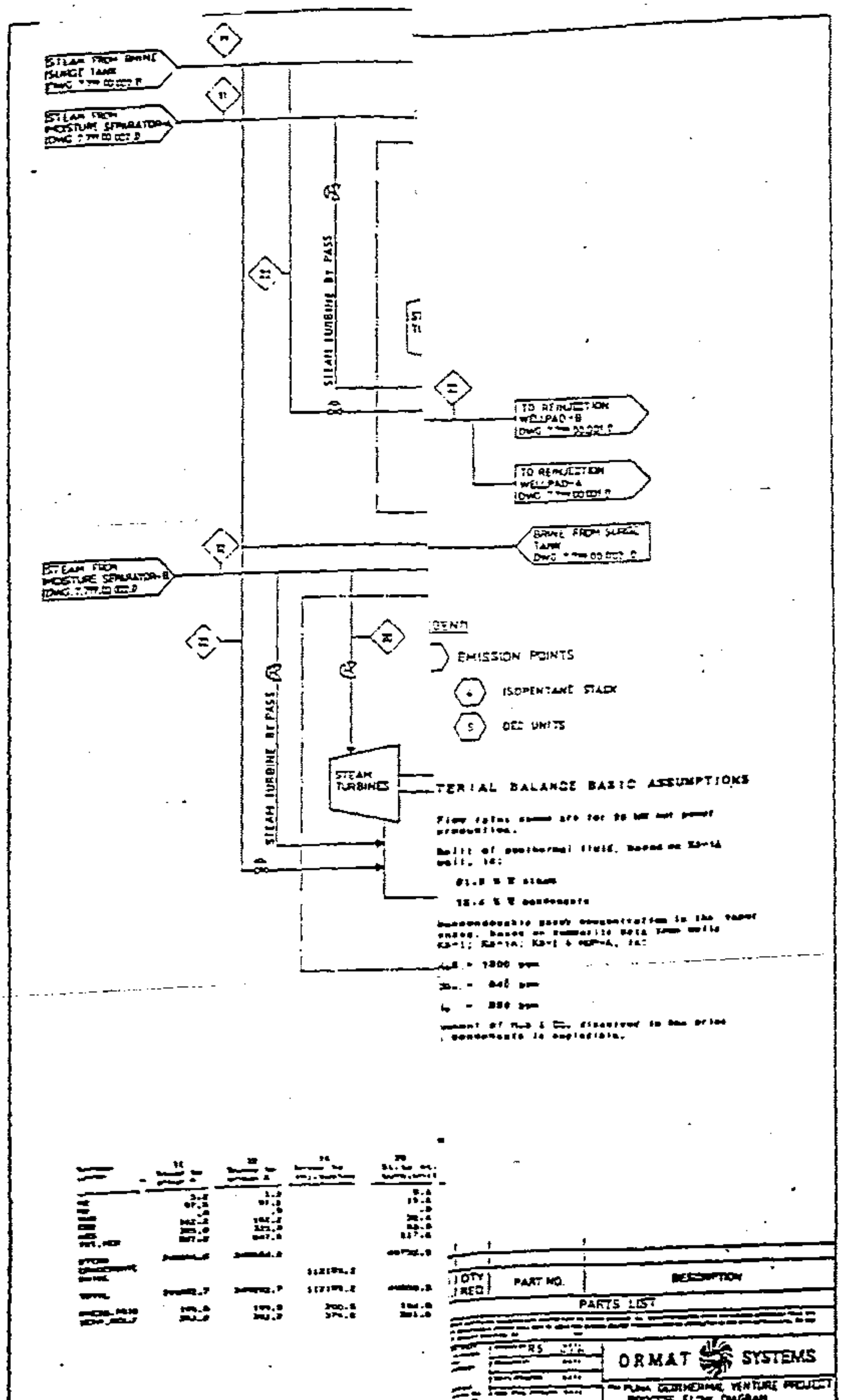
FIGURE 3

FIGURE 4



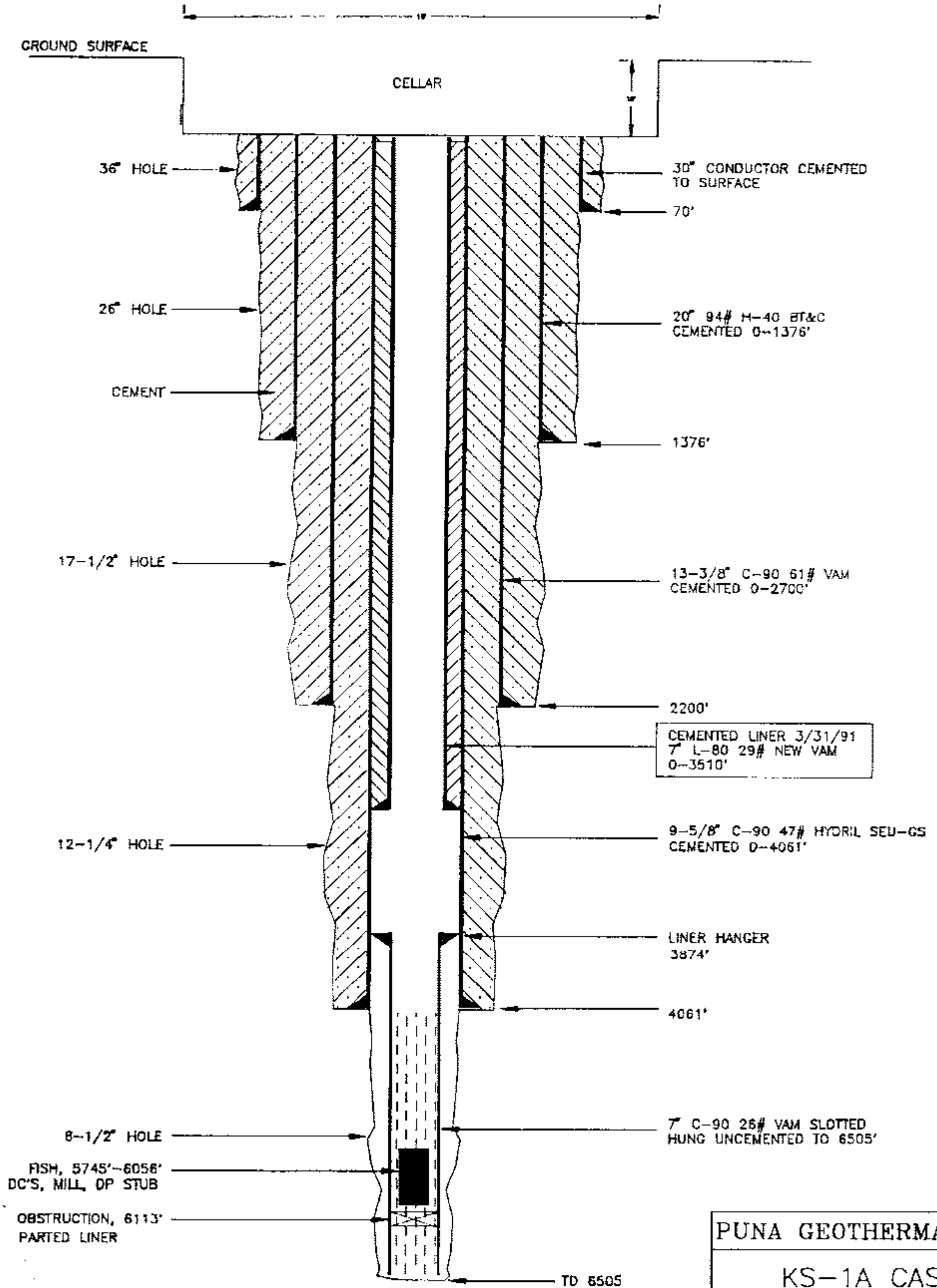

Location of the Puna District

FIG' 5




ocess Flow Diagram

FIGURE 6




| PUNA GEOTHERMAL VENTURE | | |
|---|---|---|
| KS-1A CASING SCHEMATIC AFTER REWORK | | |
| DATE 5/13/91 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 6 |

TABLE 1

Puna Geothermal Venture Project
Geothermal Resource Permit Application Amendment

Composite Geothermal Fluid Chemical Composition

| Element | Brine[a] (ppmw) | | | Steam Condensate[a] (ppmw) |
|---|---|---|---|---|
| Na | 600 | - | 10,000 | 0.17 |
| K | 123 | - | 2,700 | 0.1 |
| Ca | 40 | - | 920 | 0.1 |
| Mg | 1 | - | 2 | <0.1 |
| Fe | <1 | - | 8.4 | 0.05 |
| Mn | <1 | - | 8.5 | - |
| B | 4 | - | 11 | <0.5 |
| Br | 40 | - | 80 | - |
| I | <20 | | | - |
| F | 0.2 | - | 0.9 | - |
| Li | 1 | - | 9 | <0.01 |
| Cl | 925 | - | 21,000 | <2 |
| NH | <0.01 | - | 0.10 | 0.12 |
| $SO_3$[b] | 9.2 | - | 24 | 13 |
| Hg | <0.001 | - | <0.05 | - |
| As | 0.09 | - | 0.4 | <0.01 |
| S[c] | 5 | - | 100 | - |
| Total Alkalinity | ≤10 | | | <10 |
| $HCO_3$ | 0 | - | 18 | 0 |
| $CO_3$ | 0 | | | 0 |
| $SiO_2$ | 420 | - | 1,500 | 0.7 |
| TSS | 70 | | | - |
| TDS[d] | 2,500 | - | 35,000 | 15 |
| pH | ≤5 | - | 5.5 | 3.5 |
| Conductivity (mhos/cm) | 3,100 | - | 67,000 | 120 |
| Density | 1.03 | | | - |

Composite data from three wells on the PGV site (KS-1, KS-1A, and KS-2) and the HGP-A well.

[a]Wellhead pressure = 155 psig;
Wellhead temperature = 368°F
[b]Concentration high due to oxidation of $S^{=}$ to $SO_4$
[c]Concentration low due to oxidation of $S^{=}$ to $SO_4$
[d]TDS = Total Dissolved Solids

TABLE 2

# PUNA GEOTHERMAL VENTURE
# COMPARISON OF WATER CHEMISTRIES
# KS-3, KS-1A, PGV MONITOR WELLS
# AND PUNA DISTRICT WATER SUPPLY WELLS

| | Monitor Wells | | Public Water Wells | | KS-3 | KS-1A |
|---|---|---|---|---|---|---|
| Constituents (mg/l) | MW-1 | MW-2 | Pahoa | Kapoho | Brine | Brine |
| Arsenic | ND | ND | ND | ND | ND | ND |
| Selenium | ND | ND | ND | ND | ND | ND |
| Mercury | 0.0002 | 0.0005 | 0.0004 | 0.0005 | NA | NA |
| Cadmium | ND | ND | ND | ND | ND | ND |
| Lead | ND | ND | ND | ND | ND | ND |
| Chromium | ND | ND | ND | ND | ND | ND |
| Barium | ND | ND | ND | ND | 104.75 | ND |
| Silver | ND | ND | ND | ND | ND | ND |
| Lithium | 0.05 | 0.08 | ND | ND | 16.28 | 7.70 |
| Boron | 0.13 | 0.18 | 0.13 | 0.13 | 23.34 | 8.40 |
| Silica | 102.00 | 9.10 | 55.80 | 58.30 | 1399.16 | 1390.00 |
| Sodium | 58.20 | 228.00 | 20.00 | 74.60 | 22674.93 | 9805.00 |
| Vanadium | 0.02 | ND | 0.04 | 0.11 | ND | ND |
| Nickel | ND | ND | ND | ND | ND | ND |
| Bromide | ND | ND | ND | ND | ND | ND |
| Nitrate | 0.37 | 0.04 | 0.42 | 2.64 | NA | NA |
| Fluoride | 0.31 | 1.18 | 0.29 | 0.23 | 2.00 | ND |
| Chloride | 19.40 | 401.00 | 5.50 | 91.00 | 50100.00 | 19465.00 |
| Calcium | 19.20 | 24.00 | 3.02 | 34.10 | 3948.92 | 838.00 |
| Magnesium | 12.50 | 12.00 | 2.76 | 20.60 | 58.32 | 0.00 |
| Potassium | 10.60 | 19.00 | 2.70 | 7.03 | 5288.01 | 2400.00 |
| pH | 7.67 | 7.68 | 7.79 | 7.67 | 3.58 | 4.60 |
| T.D.S. | 526.00 | 1036.00 | 195.00 | 580.00 | 85800.00 | 33929.00 |

ND: Not detected NA: Not Available

Samples from MW-1, MW-2, Pahoa and Kapoho Wells collected March 19-20, 1991

Samples of Brine from KS-3 collected during Flow Test on March 31, 1991.
Wellhead pressure = 236 psig Wellhead temperature = 395 oF

Samples of Brine from KS-1A collected during Flow Test on October 24, 1985.
Wellhead pressure = 155 psig Wellhead temperature = 365 oF

TABLE 3

# PUNA GEOTHERMAL VENTURE NONCONDENSABLE GAS COMPOSITIONS: COMPARISON OF KAPOHO STATE 3, KAPOHO STATE 1A AND OTHER PUNA GEOTHERMAL WELLS

| Constituent (ppmw) | KS-3 3/31/91 | KS-1A 10/24/85 | Composite Wells | Power Plant Design Composition |
|---|---|---|---|---|
| Carbon Dioxide | 487.00 | 430.00 | 250 - 1,042 | 600 |
| Hydrogen Sulfide | 654.00 | 1000.00 | 800 - 1,300 | 1300 |
| Ammonia | 0.17 | <1.3 | - | - |
| Argon | 0.30 | 3.10 | 6 - 13 | - |
| Nitrogen | 13.10 | 210.00 | 10 - 700 | 50 |
| Methane | 1.55 | <0.3 | - | - |
| Helium | - | <0.005 | <0.009 | - |
| Hydrogen | 13.20 | 10.00 | 11 - 1,412 | 20 |
| Radon (pCi/L) | | 2430.00 | | |
| Total NCG | 1170.00 | 1655.00 | 1500 - 2200 | 1970 |

| | |
|---|---|
| Composite Wells: | KS-1, KS-1A, KS-2 and HGP-A<br>Wellhead pressure = 155 psig<br>Wellhead temperature = 368 oF |
| KS-3: | Wellhead pressure = 236 psig<br>Wellhead temperature = 395 oF |
| KS-1A: | Wellhead pressure = 155 psig<br>Wellhead temperature = 365 oF |
| Power Plant: | Backpressure = 210 psig<br>Temperature = 230 oF |

TABLE 4

KAPOHO STATE 1A GEOLOGY SUMMARY

| MEASURED DEPTH (K.B.) | LITHOLOGY |
|---|---|
| Surface to 1386 ft. | No sample; Drilled with no returns |
| 1386 to 2770 ft. | Subbaerial Basalts: Intercalated lava flows, cindery basalts, scoria zones and weathered interfaces. Two types of basalts occur as vesicular and non-vesicular flows:<br><br>1. Olivine-Tholeiitic basalt: rare to trace, locally common, phenocrysts of olivine and subordinate plagioclase in an aphanitic to glassy groundmass.<br><br>2. Differentiated Tholeiitic basalts: porphyritic with common to abundant phenocrysts of olivine, plagioclase and pyroxene in a fine-grained holocrystalline to hyalocrystalline groundmass composed of microlites of plagioclase, pyroxene and magnetite. Includes a small percentage of intrusive dikes. |
| 2770 to 3790 ft. | Transitional Zone: Hyaloclastites (layered units composed of granular fragments of volcanic glass, locally conglomeritic, derived from basaltic ash eruptions, littoral deposits and black sand deposits) intercalated with differentiated basalts and less commonly tholeiitic basalts. Differentiated basalts represent intrusive dikes or surface flows. Tholeiitic basalts probably deposited as submarine pillow basalts or surface flows. |
| 3790 to 6140 ft. | Submarine Basalts: Tholeiitic pillow basalts, glassy, aphanitic basalt with rare to trace, locally common, phenocrysts of olivine and plagioclase, intercalated with minor units of hyaloclastite. Section is cross-cut by microporphryritic to porpyritic intrusive dikes composed of differentiated basalt, phenocrysts of plagioclase, olivine and pyroxene in a holocrystalline groundmass of plagioclase, pyroxene and magnetite. Coarse-grained diabasic unit of differentiated basalt encountered between 4700 and 4740 ft. |
| 6140 to 6505 ft. | Intrusive Dike Complex: Microporphyritic to porpyritic differentiated intrusive basalts as above with subordinate thin intervals of pillow basalts and hyaloclastite deposits. |

# APPENDIX I

GEOTHERMAL RESOURCE SUBZONE
(KAPOHO SECTION)

| TAX MAP KEY | AREA (ACRES) | LAND USE CLASSIF. | LAND OWNERS | |
|---|---|---|---|---|
| ✓1-4-01-10(POR.) | 258.69 | AG/3ac | KAPOHO LAND AND DEV. CO. LTD. | |
| 1-4-01-13 | 3.21 | AG/3ac | KAPOHO LAND AND DEV. CO. LTD. | |
| | | | KAPOHO PROPERTIES INC. etal | |
| 1-4-01-21(POR.) | 15.95 | AG/3ac | MURPHY, JOHN E. etal | |
| 1-4-01-26(POR.) | 1.01 | AG/3ac | REID, RANDOLPH K./LAURIE B. | |
| 1-4-01-27(POR.) | 2.41 | AG/3ac | REID, RANDOLPH K. etal | |
| | | | WALKER, VIVIAN | |
| 1-4-01-28(POR.) | 0.69 | AG/3ac | IMAINO, PAUL M. | |
| 1-4-01-31(POR.) | 5.44 | AG/3ac | SHINOE, YOSHIO/HELENE TRS. | |
| 1-4-01-32(POR.) | 5.35 | AG/3ac | SHINOE, YOSHIO/HELENE TRS. | |
| 1-4-01-33(POR.) | 17.51 | AG/3ac | KLINGENSTEIN, CLARA L. | |
| | | | R.C. ROBERTS AND CO. | |
| | | | KENNY, DUANE | |
| 1-4-01-40(POR.) | 8.47 | AG/3ac | KLINGENSTEIN, CLARA L. | |
| 1-4-01-41 | 5.00 | AG/3ac | CHOW, WILLIAM PC/HARRIET L. | |
| 1-4-01-46(POR.) | 3.54 | AG/3ac | MEACHUM, DOUGLAS F./JUDY | |
| 1-4-01-50 | 10.87 | AG/3ac | MARTIN, CARY L. | |
| 1-4-01-51 | 13.67 | AG/3ac | YOZA, ALLAN M. | |
| 1-4-01-52 | 10.87 | AG/3ac | MARTIN, BETTY L. | |
| 1-4-01-53 | 20.71 | AG/3ac | CHANG, KALEONANI S. | |
| | | | COLEMAN, KALEONANI | |
| 1-4-01-54(POR.) | 13.00 | AG/3ac | SHIMOZONO, JAMES A. etal | |
| 1-4-01-55(POR.) | 9.39 | AG/3ac | PLUMERIA FARMS AND ENT. INC. | |
| 1-4-01-56(POR.) | 3.58 | AG/3ac | YAMADA, RYUICHI/ A., etal | |
| | | | TEASDALE, RAYMOND | |
| 1-4-01-59 | 26.06 | AG/3ac | PERRY, DELAN A./JENNIFER V. | |
| 1-4-01-60 | 18.74 | AG/3ac | HANSHAW, FREDERICK J. | |
| 1-4-01-63(POR.) | 3.00 | AG/3ac | CHOW, ROBERT etal TR. | |
| 1-4-01-64 | 585.76 | AG/1ac | KAPOHO PROPERTIES INC. etal/BARNWELL IND. INC. | |
| 1-4-01-65 | 142.54 | AG/1ac | INDEX INC. etal | |
| 1-4-01-66(POR.) | 73.46 | AG/1ac | INDEX INC. etal/ VIKING PROPERTIES INC. | |
| 1-4-01-67(POR.) | 64.28 | AG/1ac | KAPOHO PROPERTIES INC. etal/BETTENCOURT GEORGE C/E A | |
| 1-4-01-68(POR.) | 32.14 | AG/1ac | PUNA SUGAR CO. LTD. | |
| 1-4-01-69(POR.) | 26.73 | AG/1ac | KAPOHO PROPERTIES INC. etal/VIKING PROPERTIES INC. | |
| 1-4-01-70 | 414.25 | AG/3ac | KAPOHO PROPERTIES INC. etal/BARNWELL IND. INC. | |
| 1-4-01-72 | 0.61 | AG | KAPOHO PROPERTIES INC. etal | |
| 1-4-01-81(POR.) | 1.17 | AG/3ac | REID, RANDOLPH K./ LAURIE B. | |
| 1-4-02-2 | 1089.30 | CONS-L | KAPOHO LAND AND DEV. CO. LTD. | |
| 1-4-02-10 | 180.47 | AG/10ac | DAIICHI SEIKO OF HAWAII INC. | |
| 1-4-02-11 | 2.69 | AG/10ac | STATE OF HAWAII | |
| ✓1-4-02-18 | 454.89 | SPLIT | KAPOHO LAND AND DEV. CO. LTD. | SPLIT:AG/123.52:CONS-L/331.3 |
| 1-4-02-27 | 20.00 | AG/10ac | BISHOP B.P. TR. EST. | |
| | | | HANOHANO, EPHRAIM K./FELISA | |
| ✓1-4-02-31 | 303.87 | SPLIT | KAPOHO LAND AND DEV. CO. LTD. | SPLIT:AG/256.29;CONS-L/47.58 |
| ✓1-4-02-32 | 444.50 | SPLIT | KAPOHO LAND AND DEV. CO. LTD. | SPLIT:AG/357.50;CONS-L/87.00 |
| 1-4-02-34(POR.) | 323.56 | AG/10ac | RICHFIELD OF HAWAII INC. etal | |
| 1-4-02-37(POR.) | 36.00 | AG/10ac | BISHOP B.P. TR. EST. | |
| | | | IKEDA, LEIGHTON | |
| ✓1-4-02-40 | 48.44 | AG/3ac | KAPOHO LAND AND DEV. CO. LTD. | |
| 1-4-02-41 | 10.08 | AG/10ac | KAPOHO LAND AND DEV. CO. LTD. | |

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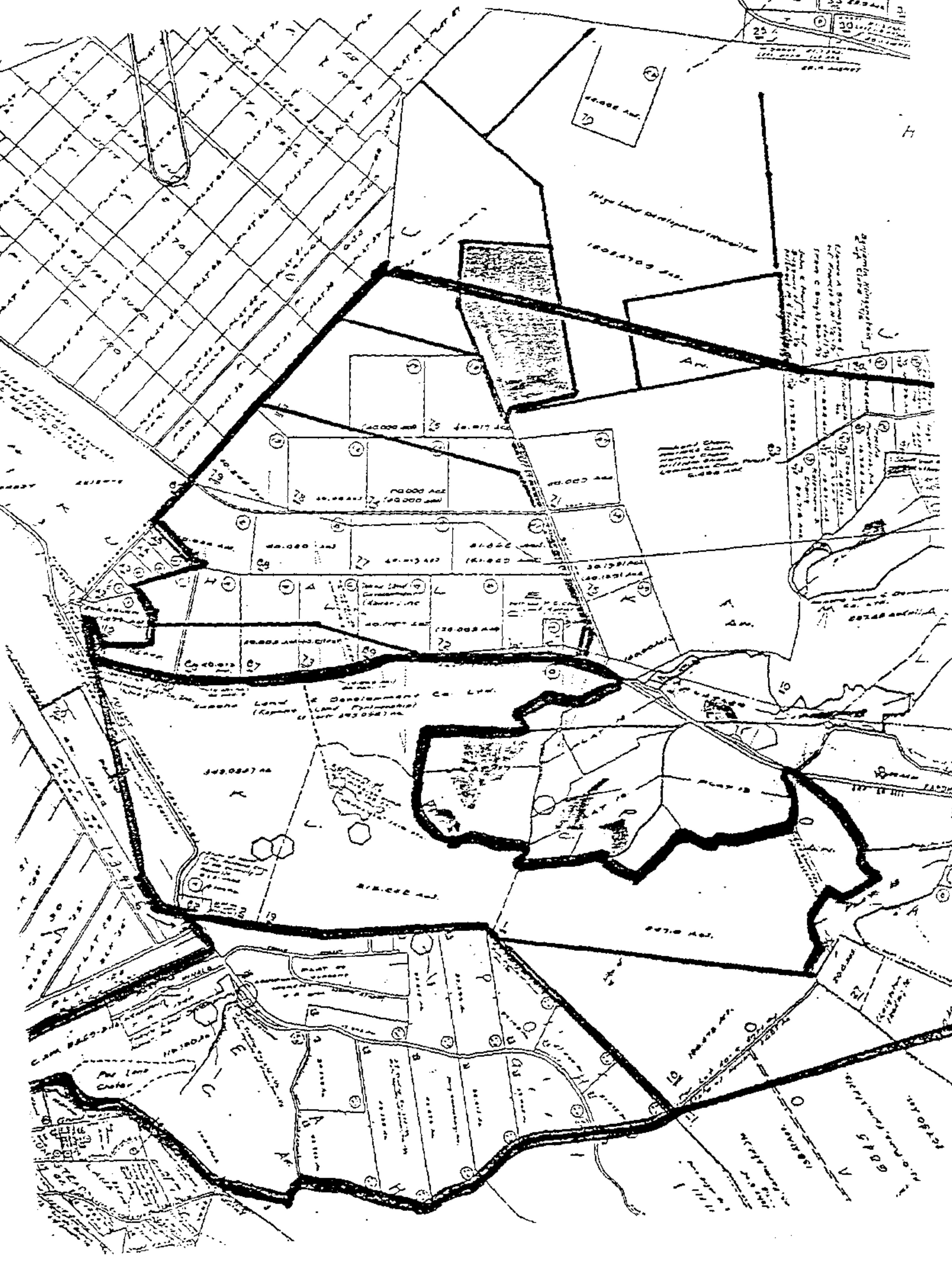
PRELIMINARY
SUBJECT TO



# Harrison Engineers

| | |
|---|---|
| Memorandum to: | Bill Teplow, Zvi Reiss, Tom Kizis |
| From: | Roger Harrison |
| Date: | 2 April, 1992 |
| **Subject:** | **Report on Casing Inspection and 12 Hour Injection Test of KS-1A** |

## 1. Summary

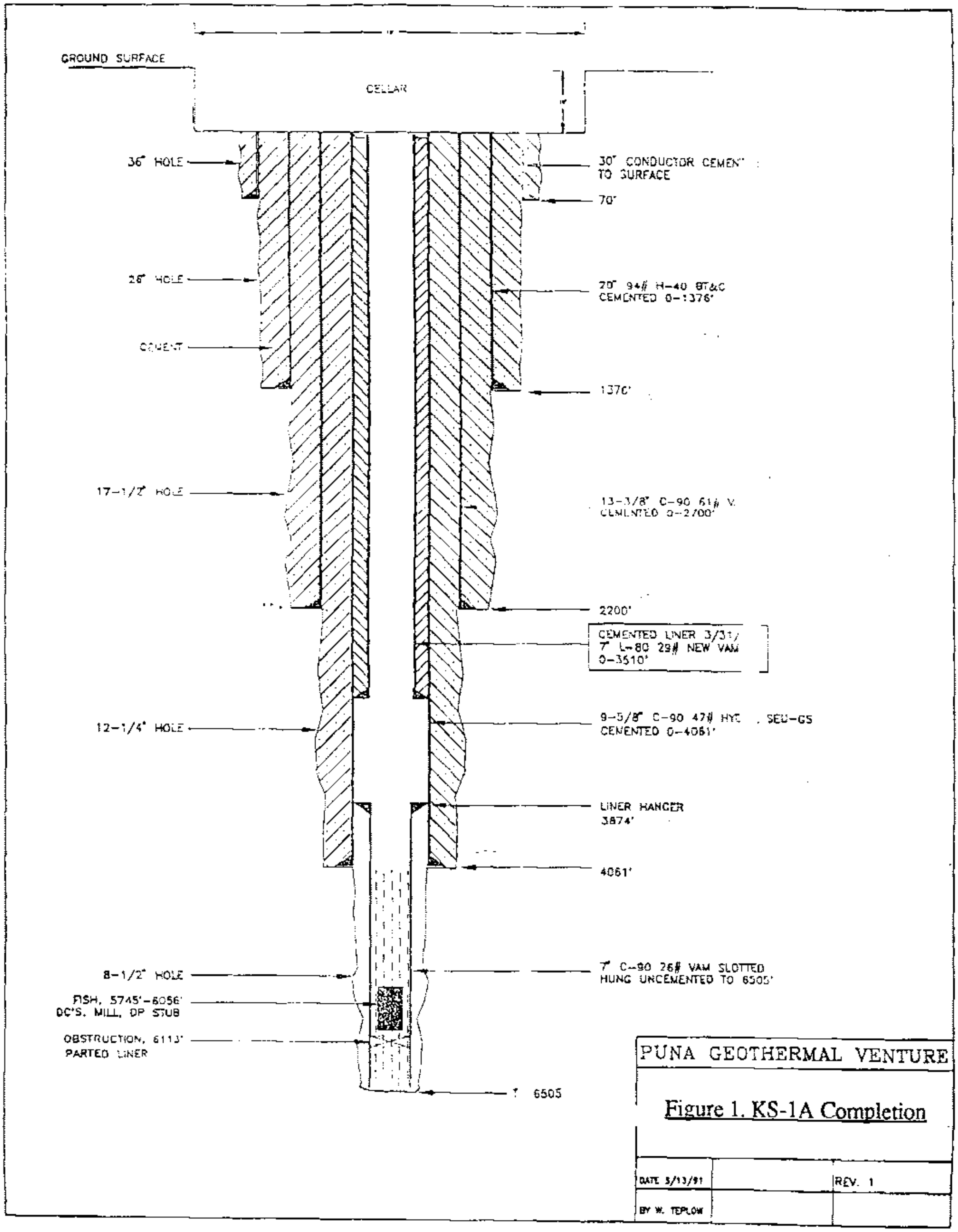
Casing inspection surveys and a 12 hour injection test were undertaken on KS-1A between March 14 and 20, 1992 in preparation for converting it to an injection well.

A four arm minimum inside diameter caliper and electromagnetic casing inspection (CIT) tool were run to ascertain the condition of the 7" cemented sleeve from 3510 feet to the surface. The surveys indicated the casing is in good condition with no evidence of scale or corrosion.

The injection test consisted of injecting fresh water supplied from the project site water wells for a continuous period of 12 hours. At the end of the test the well was taking 451 gpm at a wellhead pressure of 208 psi. The injectivity index derived from downhole pressure changes measured after the injection was shut-off was 0.8 gpm/psi.

The power plant injectate is expected to be at a temperature of 200°F. Using the injectivity determined from the test, the calculated injection capacity of the existing KS-1A completion when disposing power plant fluid is 400 gpm at the design wellhead pressure of 150 psi. Alternatively, the injection capacity is 370 gpm if a 5 1/2" liner is hung inside the 7" sleeve.

10 Landscape Road Epsom, Auckland Ph: 64 9 6388693 Fax: 64 9 6315539 New Zealand
1516 Oak Street, #311 Alameda, California 94501 USA




PUNA GEOTHERMAL VENTURE

Figure 1. KS-1A Completion

## 2. Introduction

The well completion of KS-1A is shown in figure 1. A 7" sleeve was cemented inside the original 9 5/8" production casing from the surface to 3510 feet in 1991 in order to repair a damaged connection at 2910 feet and to facilitate rebuilding of the wellhead. The cemented 7" casing was inspected using Halliburton Logging Services instruments and logging equipment on March 14, 1992. A minimum ID log (4 arm caliper) was initially run from the bottom of the 7" sleeve at 3,510 feet to the surface. An electromagnetic casing inspection (CIT) survey was then run through the same interval.

A 12 hour injection test of KS-1A was conducted on 19 March, 1992. The test facilities are shown in figure 2 and comprised two Halliburton pumping units hooked in parallel through temporary piping to the permanent eight inch injection line to KS-1A. Water for the pumps was drawn from a 40,000 gallon Baker tank which was continuously recharged during the test by the two fresh water wells at the project site. The injected water temperature was 104°F. Flowrate was measured using an orifice type flowmeter installed a few feet upstream of the wellhead. Wellhead pressure was measured by a pressure gage installed on the three inch side outlet valve on the wellhead.

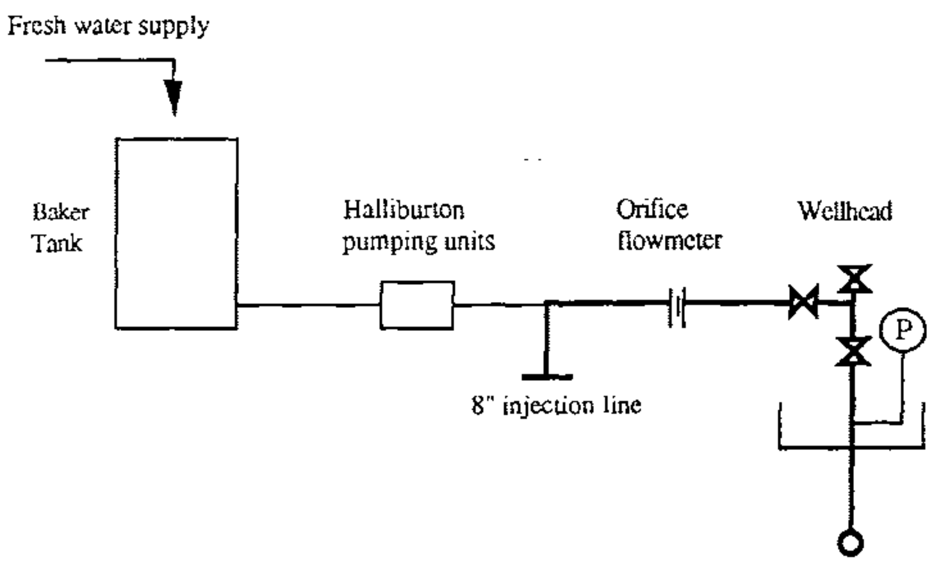



Figure 2. Injection Test Facilities

A number of downhole measurements were conducted during the test. A combination spinner - temperature survey was run in the cemented 7" sleeve during injection to check the mechanical integrity of the casing. Also, a pressure - temperature survey was run to 5,000 feet toward the end of the injection period. The instruments were subsequently suspended at 5,000 feet for 7 hours after injection was terminated to record pressure fall-off.

A further pressure - temperature survey was run on March 20, 1992 , about 36 hours after the injection test.

## 3. Results

### 3.1 Casing Inspection

The minimum ID caliper and CIT inspection tools indicated the 7" sleeve was in good condition with no evidence of scale or corrosion.

### 3.2 Injection Test

The flowrate and wellhead pressure recorded during the test are presented in table 1 and figure 3. At the end of the 12 hour pumping period the flowrate was 450 gpm and the wellhead pressure was 208 psig.

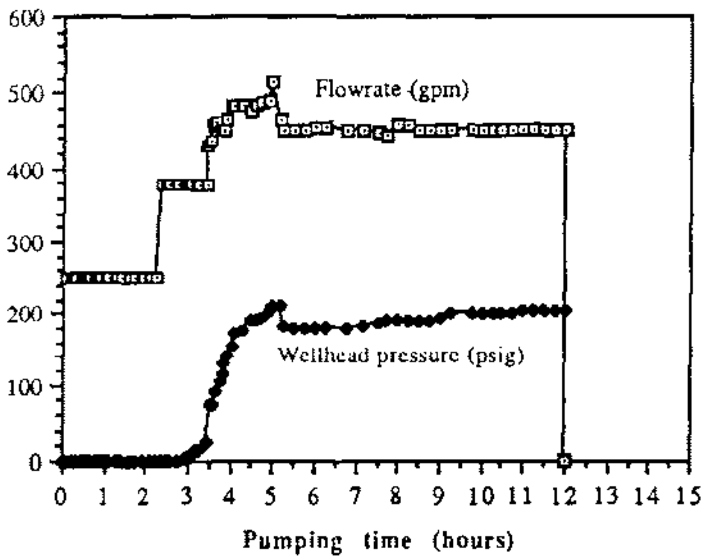



Figure 3. KS-1A 12 hour injection test, 18 March, 1992

Table 1. KS-1A 12 hour injection test data, 18 March, 1992

| Time 17-Mar-92 | Pumping Time (hrs) | Flowrate (gpm) | Wellhead Pressure (psig) | Injectivity Index (gpm/psi) | Comments |
|---|---|---|---|---|---|
| 07:45 | 0.00 | | 0 | | Start Pumping |
| 07:50 | 0.08 | 252 | 0 | | Inj. water temp = 104 F |
| 07:55 | 0.17 | 252 | 0 | | |
| 07:57 | 0.20 | 252 | 0 | | |
| 08:00 | 0.25 | 252 | 0 | | |
| 08:05 | 0.33 | 252 | 0 | | |
| 08:10 | 0.42 | 252 | 0 | | |
| 08:15 | 0.50 | 252 | 0 | | |
| 08:20 | 0.58 | 252 | 0 | | |
| 08:25 | 0.67 | 252 | 0 | | |
| 08:30 | 0.75 | 252 | 0 | | |
| 08:35 | 0.83 | 252 | 0 | | |
| 08:40 | 0.92 | 252 | 0 | | |
| 08:45 | 1.00 | 252 | 0 | | |
| 08:50 | 1.08 | 252 | 0 | | |
| 09:00 | 1.25 | 252 | 0 | | |
| 09:10 | 1.42 | 252 | 0 | | |
| 09:20 | 1.58 | 252 | 0 | | |
| 09:30 | 1.75 | 252 | 0 | | |
| 09:40 | 1.92 | 252 | 0 | | |
| 09:50 | 2.08 | 252 | 0 | | |
| 10:00 | 2.25 | 252 | 0 | | |
| 10:08 | 2.38 | 378 | 0 | | |
| 10:15 | 2.50 | 378 | 0 | | |
| 10:20 | 2.58 | 378 | 0 | | |
| 10:30 | 2.75 | 378 | 0 | | |
| 10:40 | 2.92 | 378 | 2 | | |
| 10:45 | 3.00 | 378 | 2 | | |
| 10:50 | 3.08 | 378 | 7 | | |
| 10:55 | 3.17 | 378 | 14 | | |
| 11:00 | 3.25 | 378 | 15 | 0.87 | |
| 11:10 | 3.42 | 378 | 25 | 0.85 | |
| 11:13 | 3.47 | 430 | | 1.03 | |
| 11:15 | 3.50 | 438 | 75 | 0.89 | |
| 11:20 | 3.58 | 460 | 75 | 0.93 | |
| 11:25 | 3.67 | 464 | 92 | 0.91 | |
| 11:30 | 3.75 | 453 | 105 | 0.86 | |
| 11:35 | 3.83 | 453 | 116 | 0.85 | |
| 11:36 | 3.85 | 453 | 130 | 0.83 | |
| 11:40 | 3.92 | 467 | 140 | 0.84 | |

Table 1. cont'd KS-3 12 hour injection test

| Time 17-Mar-92 | Pumping Time (hrs) | Flowrate (gpm) | Wellhead Pressure (psig) | Injectivity Index (gpm/psi) | Comments |
|---|---|---|---|---|---|
| 13:00 | 5.25 | 452 | 185 | 0.75 | |
| 13:15 | 5.50 | 452 | 180 | 0.75 | |
| 13:30 | 5.75 | 452 | 180 | 0.75 | |
| 13:45 | 6.00 | 456 | 180 | 0.76 | |
| 14:00 | 6.25 | 456 | 180 | 0.76 | |
| 14:03 | 6.30 | | | | Start Spinner Survey |
| 14:23 | 6.63 | 453 | 180 | 0.76 | |
| 14:30 | 6.75 | 453 | 180 | 0.76 | |
| 14:54 | 7.15 | 453 | 185 | 0.75 | |
| 15:15 | 7.50 | 449 | 187 | 0.74 | |
| 15:30 | 7.75 | 445 | 190 | 0.73 | |
| 15:45 | 8.00 | 458 | 190 | 0.75 | |
| 16:00 | 8.25 | 458 | 190 | 0.75 | |
| 16:15 | 8.50 | 453 | 190 | 0.74 | |
| 16:30 | 8.75 | 451 | 190 | 0.74 | |
| 16:45 | 9.00 | 451 | 195 | 0.73 | |
| 17:00 | 9.25 | 451 | 200 | 0.73 | |
| 17:30 | 9.75 | 453 | 200 | 0.73 | |
| 17:45 | 10.00 | 453 | 200 | 0.73 | |
| 18:00 | 10.25 | 453 | 200 | 0.73 | |
| 18:15 | 10.50 | 453 | 200 | 0.73 | |
| 18:30 | 10.75 | 453 | 200 | 0.73 | |
| 18:45 | 11.00 | 453 | 205 | 0.73 | |
| 19:00 | 11.25 | 453 | 205 | 0.73 | |
| 19:15 | 11.50 | 453 | 205 | 0.73 | |
| 19:30 | 11.75 | 453 | 205 | 0.73 | |
| 19:45 | 12.00 | 453 | 205 | 0.73 | |
| 19:46 | 12.02 | 0 | | | Shut-in |

The results of the spinner - temperature survey are presented in table 2. The spinner survey showed a small quantity of flow was lost between 2,000 and 3,000 feet. The change is within the measurement accuracy of the instrument. Since no signs of casing damage were evident on the casing inspection surveys it is concluded that the casing is sound. (Note: the temperature measured by the downhole instruments is about 40°F lower than the actual injected water temperature. This is because the instruments are designed primarily to measure high temperatures and are not accurate when measuring low temperatures.)

Table 2. Spinner - temperature survey while injecting

| Depth (feet) | Temperature (F) | Spinner % of flow |
|---|---|---|
| 1000 | 64 | 100 |
| 2000 | 68 | 100 |
| 3000 | 70 | 91 |
| 3420 | 71 | 91 |

The results of the pressure - temperature survey conducted while injecting are given in table 3 and the pressure fall-off data is given in table 4.

Table 3. Pressure - temperature survey while injecting

| Depth (feet) | Temperature (F) | Pressure (psig) |
|---|---|---|
| 1000 | 65 | 611 |
| 2000 | 69 | 1038 |
| 3000 | 70 | 1461 |
| 4000 | 73 | 1877 |
| 5000 | 80 | 2305 |

Table 4. Pressure fall-off (at 5,000 feet) after injection

| Time (minutes) | Pressure (psig) | Temperature (F) |
|---|---|---|
| 0 | 2305 | 80 |
| 10 | 2205 | 90 |
| 20 | 2133 | 95 |
| 30 | 2092 | 100 |
| 90 | 1955 | 116 |
| 150 | 1896 | 127 |
| 210 | 1868 | 136 |
| 270 | 1846 | 141 |
| 330 | 1836 | 147 |
| 390 | 1827 | 154 |
| 450 | | 160 |
| 506 | 1814 | 171 |

The pressure and temperature changes at 5,000 feet are plotted in figure 4.

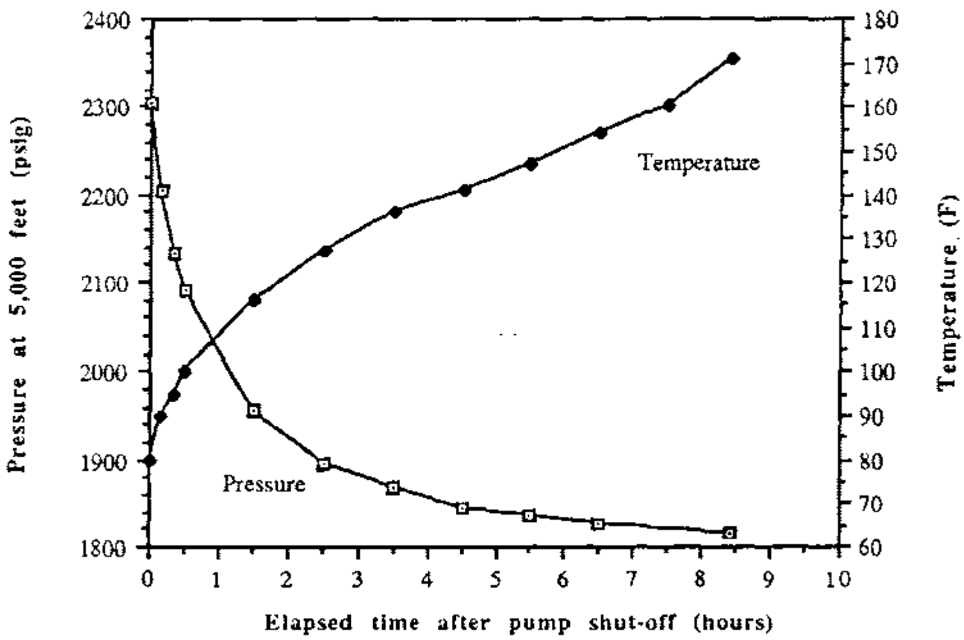



Figure 4. Pressure and Temperature changes at 5,000 feet after pump shut-off

A Horner plot of the pressure fall-off data is shown in figure 5. The calculated flow capacity is 14,800 md-ft/cp which indicates the reservoir in the vicinity of KS-1A has low permeability.

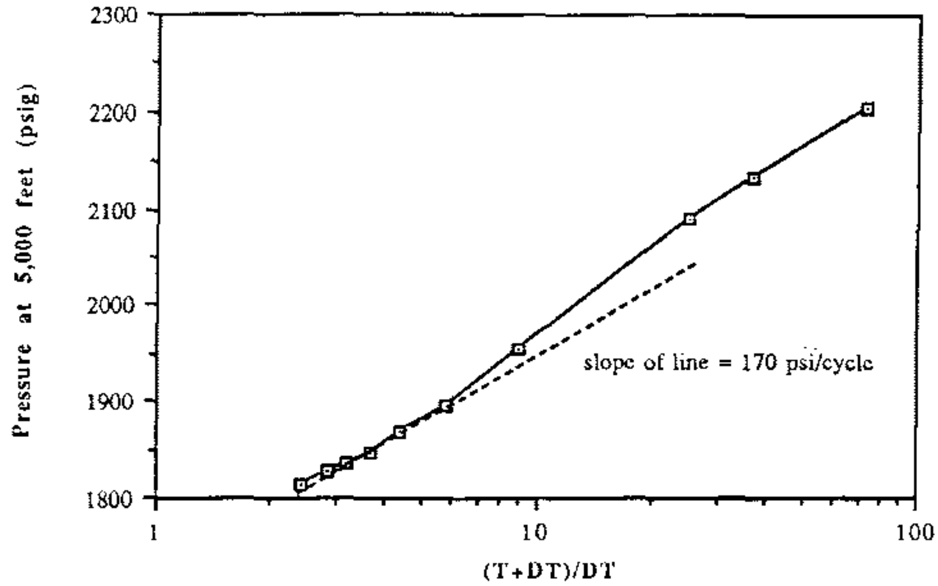



Figure 5. Horner plot of fall-off data

The pressure and temperature survey conducted on March 20, 1992, approximately 36 hours after the injection test is presented in table 5.

Table 5. Static pressure - temperature survey 20 March, 1992, 1 day after injection test

| Depth (feet) | Temperature (F) | Pressure (psig) |
|---|---|---|
| 500 | 52 | |
| 1000 | 57 | 136 |
| 1500 | 78 | 348 |
| 2000 | 108 | 566 |
| 2500 | 112 | 781 |
| 3000 | 179 | 985 |
| 3200 | 233 | 1060 |
| 3400 | 268 | 1137 |
| 3600 | 295 | 1779 |
| 3800 | 318 | 1309 |
| 4000 | 321 | 1389 |
| 4200 | 322 | 1430 |
| 4400 | 322 | 1502 |
| 4600 | 322 | 1578 |
| 4800 | 311 | 1650 |
| 5000 | 277 | 1722 |

The temperature data is plotted on figure 7. The survey exhibits a temperature reversal below 4600 feet. This indicates most of the injected water was leaving the well below this depth.

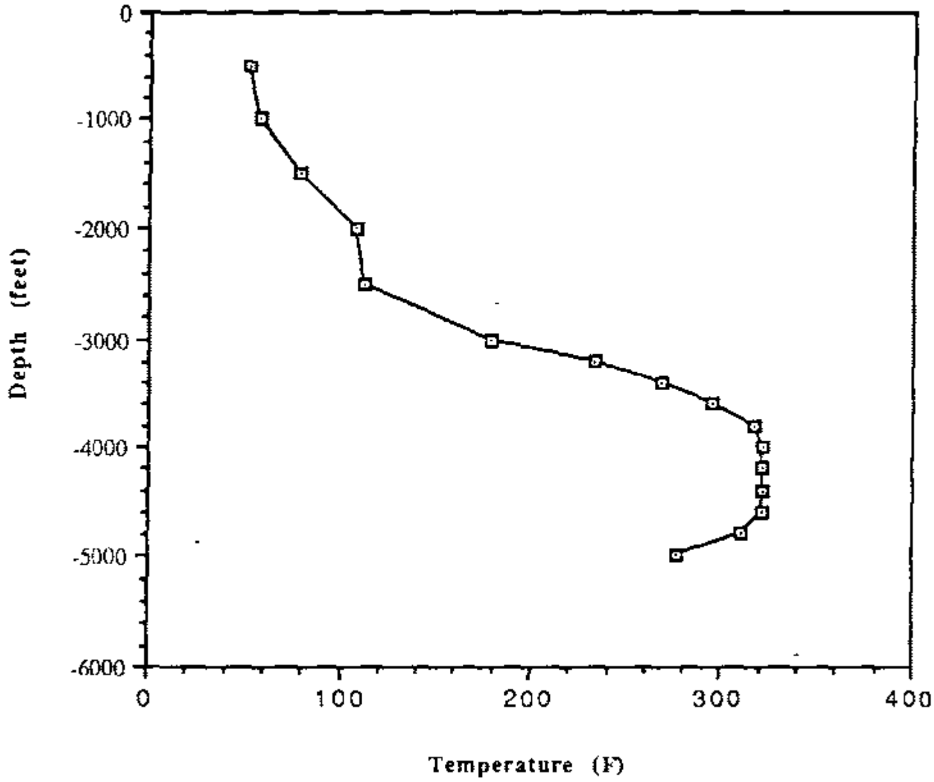



Figure 7. Static pressure - temperature survey, 20 March,1992 - 1 day after injection

The measured pressure at 5,000 feet on March 20 was 1722 psig. The total pressure change at 5,000 feet over the 36 hours or so between shutting-off injection and the March 20 survey was therefore; 2305 - 1722 = 583 psi. The injectivity index given by this is; 451 gpm / 583 psi = 0.8 gpm/psi. The injectivity index calculated for the portion of the test during which the well exhibited a positive wellhead pressure is on table 1.

## 4. Injection Capacity when Disposing of Power Plant Fluids

The injection capacity (Q) can be expressed as follows:

$$Q = II * [ WHP + WD * \rho / 144 - SP - FP ]$$

where; Q = injection flowrate (gpm)
II = injectivty index (gpm/psi)
WHP = wellhead pressure (psig)
WD = well depth to injection zone (ft)
$\rho$ = density of injection fluid (lb/ft$^3$)
SP = static pressure at injection zone (psig)
FP = wellbore friction pressure drop of fluid being injected (psi)

The power plant injection fluids will be single phase liquid (noncondensible gases will be in solution at the injection pressure) at a temperature of 200°F. In the case of KS-1A, the measured injectivity index (II) is 0.8 gpm/psi, the design injection wellhead pressure (WHP) is 150 psig, the well depth to the injection zone (WD) is assumed to be 5,000 feet, the injection fluid density ($\rho$) is 60.1 lb/ft$^3$ and the static pressure at the injection zone (SP) is 1722 psig. For the conditions relevant to this case the friction pressure drop can be expressed as follows;

$$FP = 0.91 * Q^2 / d^5$$

where d = effective internal diameter (inches)

For the existing completion (effective internal diameter approximately 6.6"), the calculated injection capacity of KS-3 is 400 gpm. For a completion with a 5 1/2" liner hung from the surface to 3,510 feet (effective internal diameter approximately 5.2") the injection capacity is 370 gpm.

## 4. Injection Capacity when Disposing of Power Plant Fluids

The injection capacity (Q) can be expressed as follows:

$$Q = II * [ WHP + WD * \rho / 144 - SP - FP ]$$

where; Q = injection flowrate (gpm)
II = injectivty index (gpm/psi)
WHP = wellhead pressure (psig)
WD = well depth to injection zone (ft)
$\rho$ = density of injection fluid (lb/ft$^3$)
SP = static pressure at injection zone (psig)
FP = wellbore friction pressure drop of fluid being injected (psi)

The power plant injection fluids will be single phase liquid (noncondensible gases will be in solution at the injection pressure) at a temperature of 200$^o$F. In the case of KS-3, the measured injectivity index (II) is 1.7 gpm/psi, the design injection wellhead pressure (WHP) is 150 psig, the well depth to the injection zone (WD) is assumed to be 5,000 feet, the injection fluid density ($\rho$) is 60.1 lb/ft$^3$ and the static pressure at the injection zone (SP) is 1779 psig. For the conditions relevant to this case the friction pressure drop can be expressed as follows;

$$FP = 0.91 * Q^2 / d^5$$

where d = effective internal diameter (inches)

For the existing 9 5/8" completion (effective internal diameter approximately 8.5"), the calculated injection capacity of KS-3 is 760 gpm. For a completion with a 7" liner hung from the surface to 3,750 feet (effective internal diameter 6.6") the injection capacity is 715 gpm.

It is likely that the injection capacity of KS-3 will increase with time under continuous long term injection as cool fluids migrate away from the wellbore and sink in the reservoir. As a result the injection capacities calculated here should be considered minimum values.

# PUNA GEOTHERMAL VENTURE
*A Hawaii Partnership*

RECEIVED

91 DEC 16 P 3: 43

DIV. OF WATER & LAND DEVELOPMENT

December 9, 1991

Mr. William Paty
Chairperson
State of Hawaii
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

Subject: Puna Geothermal Venture Project
Well Kapoho State 1-A (KS 1-A)

Upon review of the drilling and testing results from the Puna Geothermal Venture (PGV) field development to date, PGV has decided to convert well KS 1-A from a production well to an injection well. The geologic rationale for this decision is detailed in the Hydrogeologic Model of the Puna Geothermal Venture Geothermal Resource Update dated October 22, 1991, which was submitted to your office on October 24, 1991.

The conversion of the KS 1-A well into an injection well will require execution of a Testing and Injection Program as specified in the Underground Injection Permit No. 1529. This program was submitted to the Hawaii State Department of Health (DOH) and copied to your office for review and approval on November 25, 1991.

The conversation of the KS 1-A well into an injection well is not expected to require further modification to the well at this time.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

cc:
C. Hew, DOH
J. Lewin, DOH
D. Nakano, DLNR
M. Tagamori, DLNR
E. Tanaka, DLNR

91208.011

101 Aupuni Street, Suite 1014-B, Hilo, Hawaii 96720 • (808) 961-2184 • Facsimile (808) 961-3531

Original

# PUNA GEOTHERMAL VENTURE

*A Hawaii Partnership*

November 25, 1991

Dr. John Lewin, M.D.
Director
State Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

Dear Dr. Lewin:

Subject: Puna Geothermal Venture Project
Underground Injection Control (UIC)
UIC Application No. UH-1529

Pursuant to the Authority to Construct Underground Injection Wells issued to Puna Geothermal Venture (PGV) by the State Department of Health on March 16, 1990 in the form of a letter, PGV respectfully submits the following documentation for your review and approval:

1. Production and Injection Well Casing Monitoring Program, dated November 21, 1991;

2. KS-3 Testing and Inspection program, dated November 21, 1991; and

3. KS-1A Testing and Inspection program, dated November 21, 1991.

The acceptance of these reports, along with the geologic report and the Hydrologic Monitoring program, constitute the completion of requirements for a Permit to Operate injection wells KS-1A and KS-3 under the UIC.

91194.011

101 Aupuni Street, Suite 1014-B, Hilo, Hawaii 96720 • (808) 961-2184 • Facsimile (808) 961-3531

Your timely review and acceptance of these documents is greatly appreciated. If there are any questions regarding this submittal, or the request for a permit to operate the injection wells, please feel free to contact me in the Hilo office at 961-2184.

Sincerely,

Maurice A. Richard
Vice President
Puna Geothermal Venture

Enclosures

cc:
C. Hew, DOH
D. Nakano, DLNR
M. Tagamori, DLNR

91194.011

# KS-1A TESTING AND INSPECTION

## PURPOSE:

To test injection capacity and inspect the mechanical integrity of KS-1A to convert KS-1A from a production to an injection well.

## PROCEDURE:

Run static temperature survey, perform injection test and inspect casing to assure the integrity of the completion and the injectivity of the well.

1. Rig up to run PT surveys and injection test.

   a. Run water line from water well to the location.
   b. Rig up Howco V-12 to wing valve and water line.
   c. Install lubricator on 3" swab valve. Install personnel stand.
   d. Discontinue injection at least 48 hours prior to testing so that well can retain a stable shut-in condition.
   e. Notify DLNR & DOH representatives at lease 24 hours prior to testing so they can witness the testing.

2. Perform injection test as follows:

   a. Before injecting any water, run a static pressure/temperature traverse from surface to 5,000 ft. Verify data before proceeding to next step.

   b. Kill well at 40 GPM with water until several wellbore volumes of water have been pumped to slowly cool well and casing.

   c. Increase pumping rate in 100 GPM steps holding each step for 2 hours until WHP reaches a maximum of 150 psi or until maximum available injection volume has been reached. (Approximately 1200 GPM).

   d. Hold WHP constant at 150 psi for 12 hours. Vary injection rate to maintain a constant 150 psi WHP.

   e. Run a pressure/temperature tool with 12 hour clock to 5,000 ft.

   f. Continue pumping into well for 1 hour. Shut in injection to well. Release Howco V-12.

   g. Retrieve pressure/temperature tools when clocks expire.

   h. Approximately 24 hours after shut-in, run a temperature traverse from surface to 5,000 ft. to check for interformational flow behind casing. Minimum static time to be at lease 12 hours.

3. Rig up to run casing inspection tools.

   a. Rig up Howco TC4 to wing valve and water supply.

   b. Check for casing leaks by killing well at 40 GPM with water and running a spinner/temperature survey during injection at a constant rate.

   c. Install a 10-3/4" short lubricator with union connection, bleed off and wireline pack off on the 8" master valve. Use a 10" x 8" DSA crossover.

   d. Move in crane to hang wireline sheave and handle lubricator (20 ton single line okay).

4. Run casing inspection logs as follows:

   a. Keep well dead with at least 40 GPM water.

   b. Run HLS 4 arm caliper as minimum I.D. tool in 7" casing from the bottom of 7" cemented liner at 3,510 RKB (25" above G.L.) to surface.

   c. Run HLS 60 arm Multi Finger Caliper from the bottom of the 7" cemented liner to surface.

   d. Shut in well and rig down. Interpret Logs.

5. Prepare to use well for injection service.

   a. The well has four cemented casings below the last USDW.

   b. The mechanical integrity of the casing will be ensured by the above testing to at least 3,510' RKB.

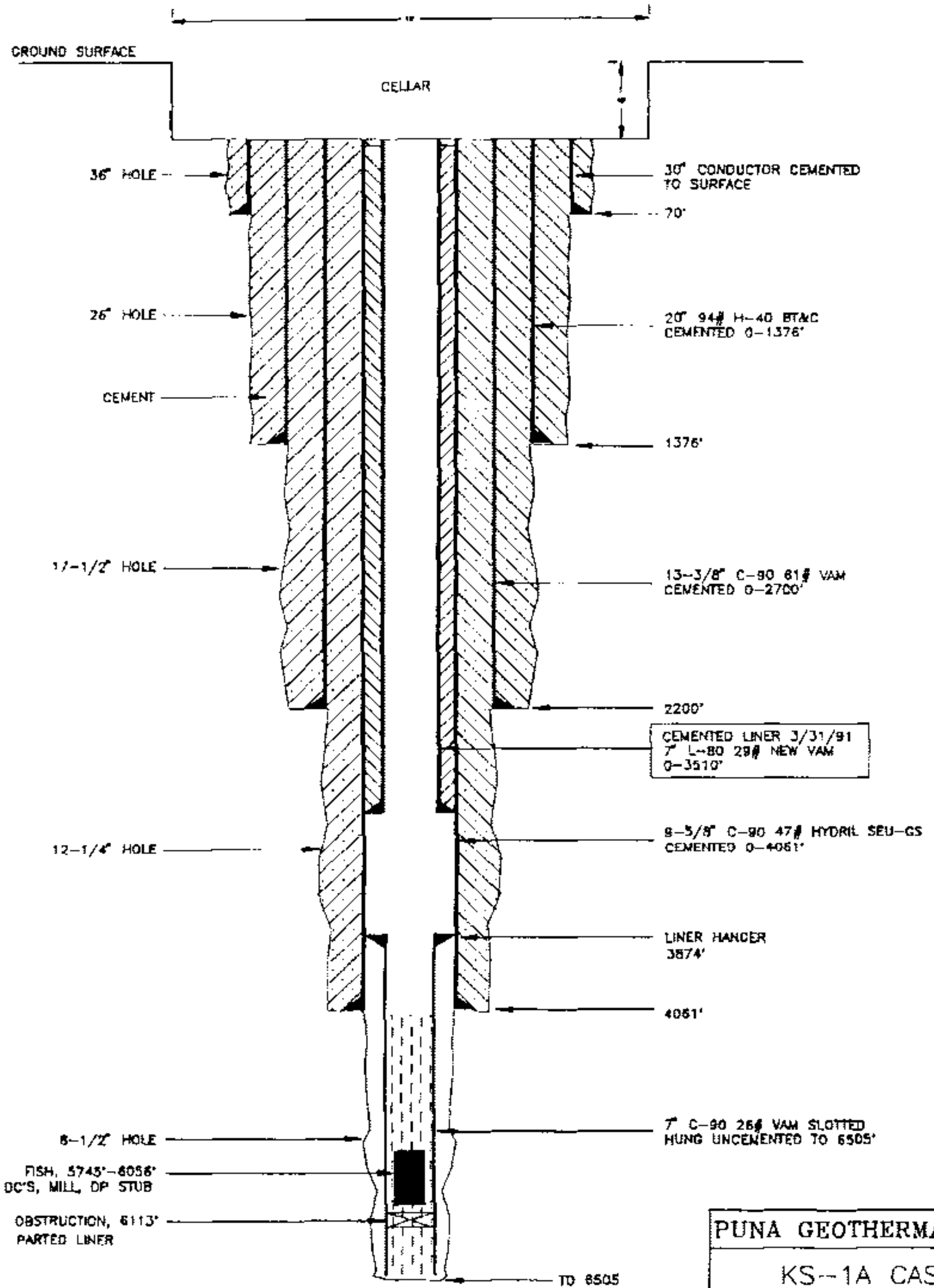
   c. We do not expect to find any mechanical problems with this well. If any of the testing indicates problems further diagnostic testing will be performed as per the Casing Monitoring Program.

   d. The 20", 13-3/8", and 9-5/8" casings were installed by the previous operator.

e. The 7" liner casing was tested during drilling to 600 psi surface pressure and test results were approved by the DLNR field representative before the casing shoe was drilled out.

f. All injection fluid will enter the geothermal zone in or below the aquitard which separates the geothermal fluids from the lower most USDW and will not migrate through the cemented annulus into the lowermost USDW.

g. This well will be used as a standby injector only. It will be used only in the event that the primary injector will not accept all of the injectate.




PUNA GEOTHERMAL VENTURE

KS-1A CASING SCHEMATIC AFTER REWORK

| | | |
|---|---|---|
| DATE 5/13/91 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 5 |

# PRODUCTION AND INJECTION WELL
# CASING MONITORING PROGRAM

## 1. INTRODUCTION

### 1.1 Background

Pursuant to Underground Injection Control (UIC) Permit No. UH-1529, the Hawaii State Department of Health (DOH) requires Puna Geothermal Venture (PGV) to develop a Casing Monitoring Program (CMP) regarding production and injection wells. This program is to be submitted to and approved by DOH prior to start of operation of injection wells drilled under permit UH-1529, for the PGV project site.

### 1.2 Purpose

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1.3 Scope

This CMP covers all production and injection wells drilled by PGV and all existing wells that were drilled by previous operators on the 500 acre PGV site which to date have not been plugged and abandoned.

1.4 Hydrogeologic Basis for the Casing Monitoring Program

The hydrogeologic basis for the CMP is derived from data available from the drilling of five production wells to depths ranging from 6500' to 8000' and by two shallow monitoring wells drilled to depths of 640' and 720' (Figure 1).

1.4.1. The shallowest zone extending from surface (approximately 620' above sea level) to about 7' above mean sea level is unsaturated and consists of a highly permeable sequence of subareal basalt flows and interflow breccias. Within the project area this zone varies in thickness from 600' to 720' depending on the surface elevation. Numerous cracks with widths of up to 2' traverse the area. These cracks are vertical or very steeply dipping and reach from the surface to at least the top of the warm unconfined aquifer described below. This is evidenced by the discharge of warm moist air from many of these cracks. The cracks trend parallel to the major structures and lineaments of the Lower East Rift Zone.

1.4.2 The zone below the unsaturated surface rock consists of an unconfined aquifer which contains ground water with varying degrees of natural contamination from the underlying geothermal system. This zone is approximately 1400' thick with the water surface elevation controlled by sea level according to the Ghyben-Herzberg model. The unconfined aquifer surface in the project area is approximately 7' above mean sea level. Based on the model, the thickness of the low salinity lens is therefore about 280'. This constitutes the USDW. The salinity of the underlying water

will probably approach that of sea water. The temperature of the unconfined aquifer zone ranges from 95° to 192° F. in the project area and tends to be nearly isothermal throughout the entire interval, indicating good vertical mixing. A detailed description of this aquifer is given in the Puna Geothermal Venture Hydrologic Monitoring Program submitted to DOH in April 1990.

1.4.3. The interval from 1400' below sea level to 2400' below sea level (2000' to 3000' GL in Figure 2) is characterized by an extremely steep thermal gradient in the range of 30 F/100' or more. The steep temperature gradient is characteristic of conductive heat transfer and indicates the zone has essentially zero vertical permeability. Thus, the zone appears to be an effective aquitard separating the high temperature geothermal fluid below from the low temperature unconfined aquifer overlying it. Locally the aquitard exhibits natural leakage as in the area of MW-2 and GTW-III where anomalously high shallow ground water temperatures and salinities are observed.

1.4.4 Between the depths 2400' and 4300' below sea level (3000' to4900' GL in Figure 2) the temperature profile indicates the existence of a transition zone which consists of alternating permeable and impermeable strata. Within this zone are two or more alternating zones of high thermal gradients and isothermal intervals. The high average thermal gradient through this zone indicates that vertical fluid circulation is very limited.

1.4.5 Below a depth of about 4300' below sea level (4900' GL in Figure 2) the temperature profile becomes nearly isothermal. This interval is within the geothermal reservoir in which significant vertical movement of fluid is taking place at temperatures above 620 degrees F.

The casing program planned for the production and injection wells calls for cemented casing to reach from ground surface to a depth of about 3400' below sea level (Figures 3 and 4). This allows the casing to be anchored securely within the transition zone described in 1.4.4 and to fully isolate the geothermal reservoir from the shallow aquifer (lowermost USDW) with a cemented interval through the aquitard (1400'-2400' below sea level). Within the shallow aquifer zone,two cemented casing strings are installed. Three cemented casing strings pass through the top of the shallow aquifer and the unsaturated zone. The production and injection casing programs are designed to prevent leakage of geothermal fluid from the wellbore into the shallow aquifer above a depth of 1400' below sea level. The CMP discussed below provides the methods and procedures necessary to detect any leakage and to repair those leaks if detected.

## 2. PRODUCTION WELL CASING MONITORING PROGRAM

### 2.1 Pressure Testing During Drilling

Each production well is completed with three casing strings (not including the 30-inch conductor pipe) cemented to the surface (Figure 3). Immediately upon completion of cementing each casing string and prior to drilling out the cement shoe, the casing will be pressure tested. The test will consist of pressurizing the casing to a specified test pressure and holding for 30 minutes. The specified test pressure shall be the lesser of: (a) 2000 psig surface pressure or (b) 70% of the casing internal yield pressure less 250 psi at the shoe. (2000 psig is the maximum expected surface pressure on the 9-5/8" casing during production operations.) The pressure change during the 30 minute period shall not exceed 8%. The effect of the fluid expansion due to thermal recovery in the wellbore during the test period will be negligible throughout the test period.

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- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
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- Other applicable methods

After identification of the point of leakage, a cement squeeze job will be performed and the casing retested. Results of each pressure test will be reported to the Department of Land and Natural Resources (DLNR) and the Department of Health (DOH),

After a successful pressure test of each casing string, drilling will proceed to a point at least one foot below the cement shoe, and a pressure leak-off test will be performed to test the integrity of the annular cement. Each test will be performed at a pressure approaching the fracturing pressure of the exposed formation. If there is excessive leak-off, a squeeze cement job will be performed, the cement will be drilled out and the test will be repeated. Drilling will not proceed until an effective cement seal is established in the casing/borehole annulus above the shoe. In some situations, such as the case where there is natural formation permeability immediately below the casing shoe, it may not be practical to prove cement integrity with the pressure test described above. As an alternative, a standard water shutoff test (WSO) may be done above the shoe, or shut-in temperature surveys may be run.

If there have been indications of problems with the 9-5/8" cement job, a cement bond log (CBL) will be run in the 9-5/8" casing. Adequate cement curing time will be allowed before running the CBL.

Although CBL's may be of interest on the surface and intermediate casing strings, they are not planned because the necessary logging tools are not available from PGV's logging contractor to obtain meaningful results in the large diameter, 20" and 13-3/8" casing strings. CBL's are not commonly run in geothermal production and injection wells on the mainland, and they are virtually never run on the surface and intermediate casings. The large surface and intermediate casing sizes common to geothermal wells cannot be bond logged with useful results using conventional logging tools.

With regard to the surface and intermediate casing strings, if any problems are suspected from the results of the cement job or pressure testing, a static temperature survey will be run to check for interformational flows behind the casing. The shut-in time before logging will be sufficient to obtain useful results.

If the CBL is run in the 9-5/8" production casing it will be used only to determine cement tops or as a diagnostic tool. The logging results will not meet oil and gas standards for cement bond or cement compressive strength. This is due to two factors:

2.1.1 Because of the temperature limitations on logging tools, a well must be cooled by water injection during the logging operation. The resulting thermal contraction of the casing creates a temporary micro annulus between the casing and cement. Therefore, the log shows that no bond exists. This micro annulus is believed to seal after the well heats back up to the usual temperature. The micro annulus is usually so small that it would only be a problem with high pressure gas and would not provide a flow path for geothermal fluids.

2.1.2 The cement used in geothermal wells is relatively light weight, low compressive strength cement. Geothermal casing is usually cemented in place over its entire length and the cement used must be lightweight or the formation will fracture due to the hydrostatic pressure from the cement column. Fracturing and the resultant loss of circulation cause an incomplete primary cement job. Any secondary cementing procedure usually never approaches the quality of a successful primary cement job. All of the light weight cements available on the market produce relatively low compressive strengths when set. High compressive strengths are not required for geothermal wells because the casing is cemented over its entire length. This supports and protects the casing and seals off any possible flow in the annulus. This is unlike the common practice in oil and gas wells where casing is cemented only to seal off the zones of interest or fresh water zones. The main method of determining the competency of the casing cement job while drilling will be the surface indications of pressure and circulation returns during the cement job and the shoe leak-off test. If both of these are positive, the cement job has an extremely high probability of providing a good seal against the migration of production fluids.

## 2.2 Monitoring During Injection Testing

Upon completion of each production well an injection test may be performed to give an initial indication of reservoir permeability. The injection test consists of pumping relatively cool, fresh water into the wellbore at several controlled rates while monitoring downhole and wellhead pressure. Temperature-pressure-spinner (TPS) logs will normally be run during the test. These logs can be used to locate leaks in the casing by noting a sudden change in temperature with depth or a drop in flow velocity within the casing string. In the event that a loss of mechanical integrity is indicated during or after injection, one or more of the following diagnostic methods will be used to confirm the leak:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV.

## 2.3 Monitoring During Flow Testing

During flow testing of each production well, wellhead temperature and pressure along with steam and brine flow rate and chemistry are continuously monitored. After the initial 24 hours of flow, flow characteristics tend to be stable. Sudden changes in the wellhead pressure, temperature, brine/steam ratio, or brine chemistry during stabilized flow can be indicative of a loss of mechanical

integrity which is allowing cool water leakage into the wellbore.

Also during flow testing, TPS logs are periodically run. Leakage of cool water into the wellbore or loss of fluid to zones behind casing may be seen in the TPS logs run during or after shut-in. In the event that wellhead or logging data indicate a loss of mechanical integrity during the flow test, the well will be shut in and one or more of the following diagnostic methods will be used to confirm the leaks and locate it more precisely:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV

2.4 Monitoring During Production

Wellhead pressure and temperature will be monitored daily during normal production. Brine and steam chemistry will also be analyzed for each production well. Initially, samples will be taken weekly to establish a baseline geothermal fluid chemistry. The sampling frequency will then be reduced to monthly and quarterly as stabilization of the fluid chemistry is confirmed.

Casing failure causing leakage of cool ground water into the wellbore or loss of geothermal fluid to the formation may be manifested as a pressure and temperature drop at the wellhead. Fluid chemistry changes may also indicate ground water leakage. Wellhead pressure, temperature, and chemistry data will be reported to the DOH quarterly on a routine basis.

In the event that anomalous production parameters are observed, TPS survey(s) will be run with the well flowing. The TPS profiles will be used to determine whether the observed changes are due to changes in reservoir characteristics or are caused by a loss of mechanical integrity. In the event of a suspected loss of mechanical integrity, one or more of the following diagnostic methods will be used to confirm the leak and locate it more precisely:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV

2.5 Casing Repair

Once a loss of mechanical integrity is identified and approximately located, casing repair procedures will be initiated. These procedures may include any or all of the following activities:

2.5.1 Shut in well and run magnetic and multi-arm casing inspection logging tools to precisely locate leak and to evaluate casing condition.

2.5.2 Rig up workover rig on well. Run packer(s) on drillpipe and pressure test to confirm suspected leaking interval.

2.5.3 Execute cement squeeze job to seal casing leak or stop interformational flows behind casing.

2.5.4 Perform casing pressure test and other diagnostic tests as necessary to confirm success of the remedial work. If good, move rig off well and return well to production.

2.5.5 In the event of major casing failure, a cemented liner may be installed through the damaged interval.

2.5.6 Prior to drilling out the liner shoe, the liner will be pressure tested as described in Section 2.1.

2.5.7 If mechanical integrity cannot be restored satisfactorily, the well will be plugged and abandoned.

## 3. INJECTION WELL CASING MONITORING PROGRAM

### 3.1 Pressure Testing During Drilling

The cemented casing string design in PGV injection wells (Figure 4) is similar to that of production wells. Testing of each string will proceed as described in 2.1 above.

### 3.2 Monitoring During Injection Testing

Prior to installation of the hangdown liner, an injection test will be performed to measure injectivity of the open formation below the cemented 9-5/8" casing. During the test, one or more of the following logs or surveys will be run:

- TPS through the open hole and cased intervals with the well on injection.
- Static temperature surveys to check for evidence of interformational flows behind casing.
- Other logs or surveys, as determined by PGV, to check for mechanical integrity of the casing and cement.

If the results of the logs and surveys confirm mechanical integrity, then the 7" hangdown liner may be installed. If leakage is found, repair procedures as described in 2.5 will be performed.

### 3.3 Monitoring During Routine Injection

During routine injection, the 7" x 9-5/8" annulus will be purged with nitrogen. Purge pressure and flow rate will be monitored for any changes indicative of a casing leak. Purge will be repeated as necessary to maintain the fluid level more than 1/2 way down the annulus. Once annually, tests and surveys will be conducted to verify mechanical integrity of the hangdown liner. The casing and hangdown liner will be tested for leaks by one of the following procedures, or a combination thereof:

3.3.1 Perform a pump-down test on the 7" x 9-5/8"

annulus. Nitrogen will be injected into the annulus to a pressure sufficient to displace the water level to the 9-5/8" casing shoe and shut in. Surface pressure on the annulus and hangdown liner will be monitored and recorded. Annulus pressure bleed-off exceeding 8% in 30 minutes will be considered indicative of a leak. If necessary, the pressure test will be extended beyond 30 minutes to preclude thermal effects on the surface pressure. In that case, the final 30 minutes will constitute the test period.

or

3.3.2 If the hangdown liner is pulled, the casing may be pressure tested above a bridge plug or packer set near the shoe following the basic procedure outlined in Section 2.1. Integrity of the hangdown liner may be verified by inspection on the surface, by a pressure test after it is run in the hole, or by a TPS log with the well on injection.

Integrity of the cement will be checked during each workover by one or more of the following procedures:

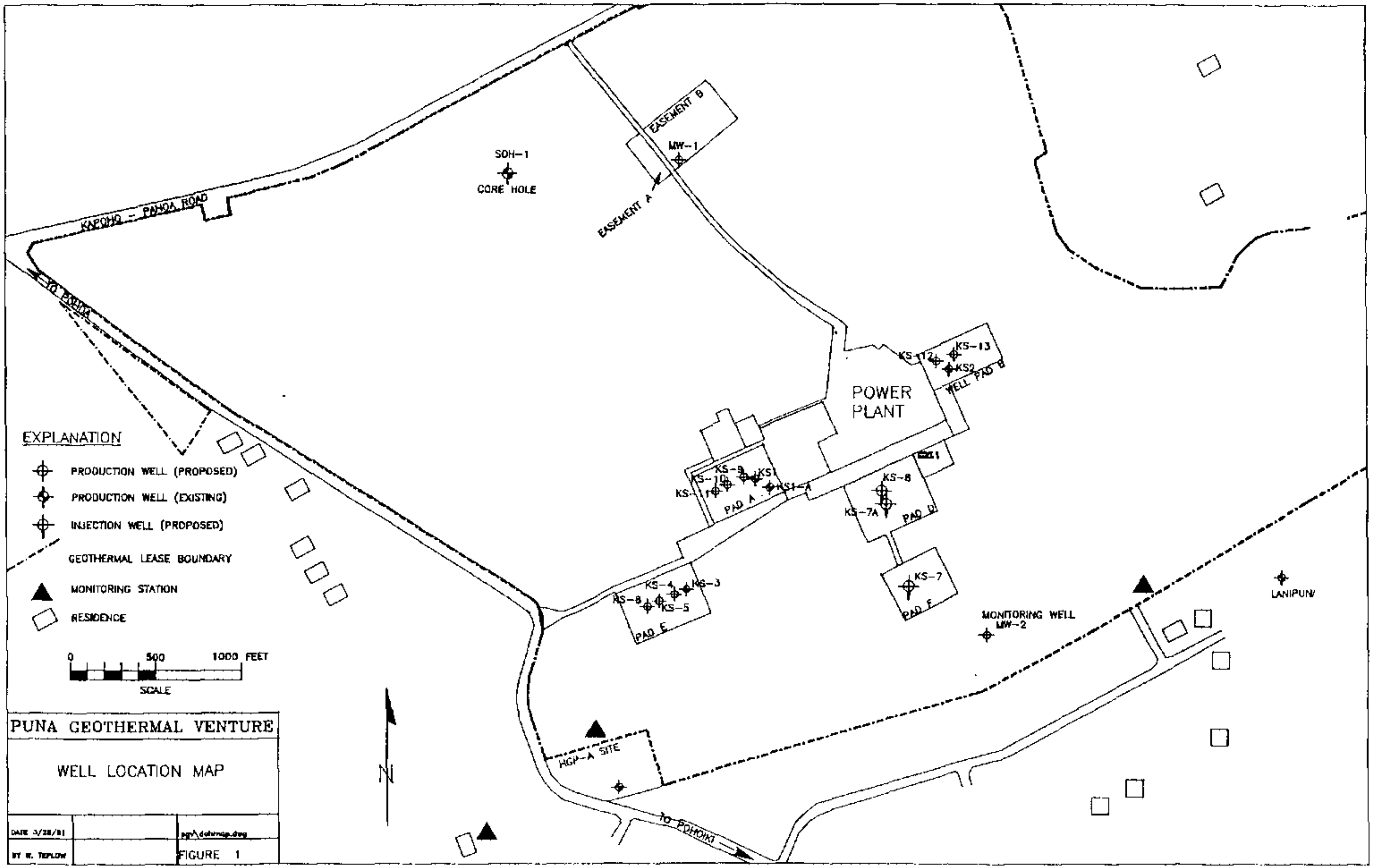
3.3.3 One or more shut-in static temperature surveys will be run. Shut-in time will be at least 12 hours, or longer if necessary to obtain meaningful results.

or

3.3.4 Other logs or surveys may be run, at the discretion of PGV, if static temperature surveys are not definitive.

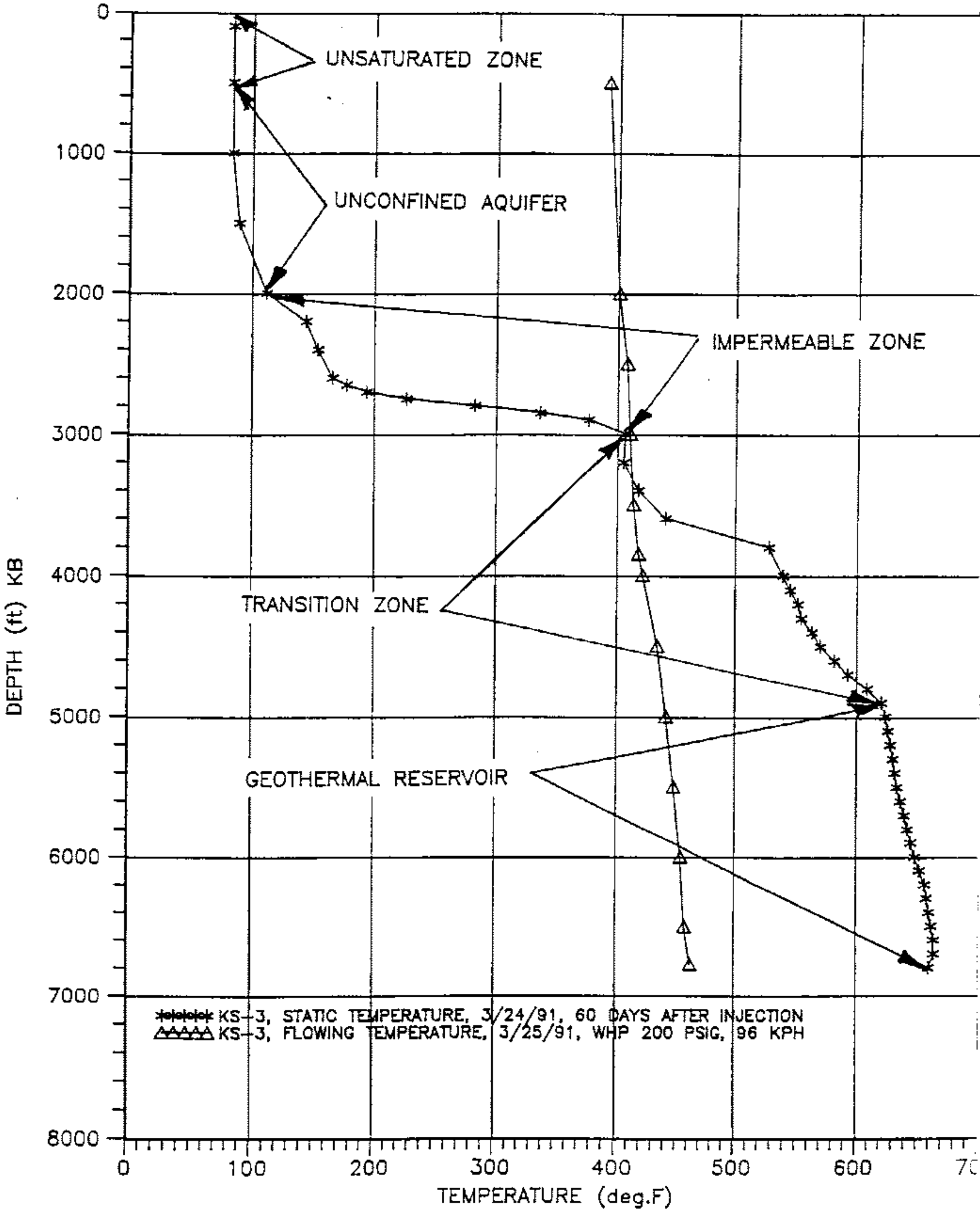
3.4 Restoration of Mechanical Integrity or Abandonment

In the event that the diagnostic procedures indicate a loss of mechanical integrity, remedial or abandonment procedures will be carried out as specified in Section 2.5.

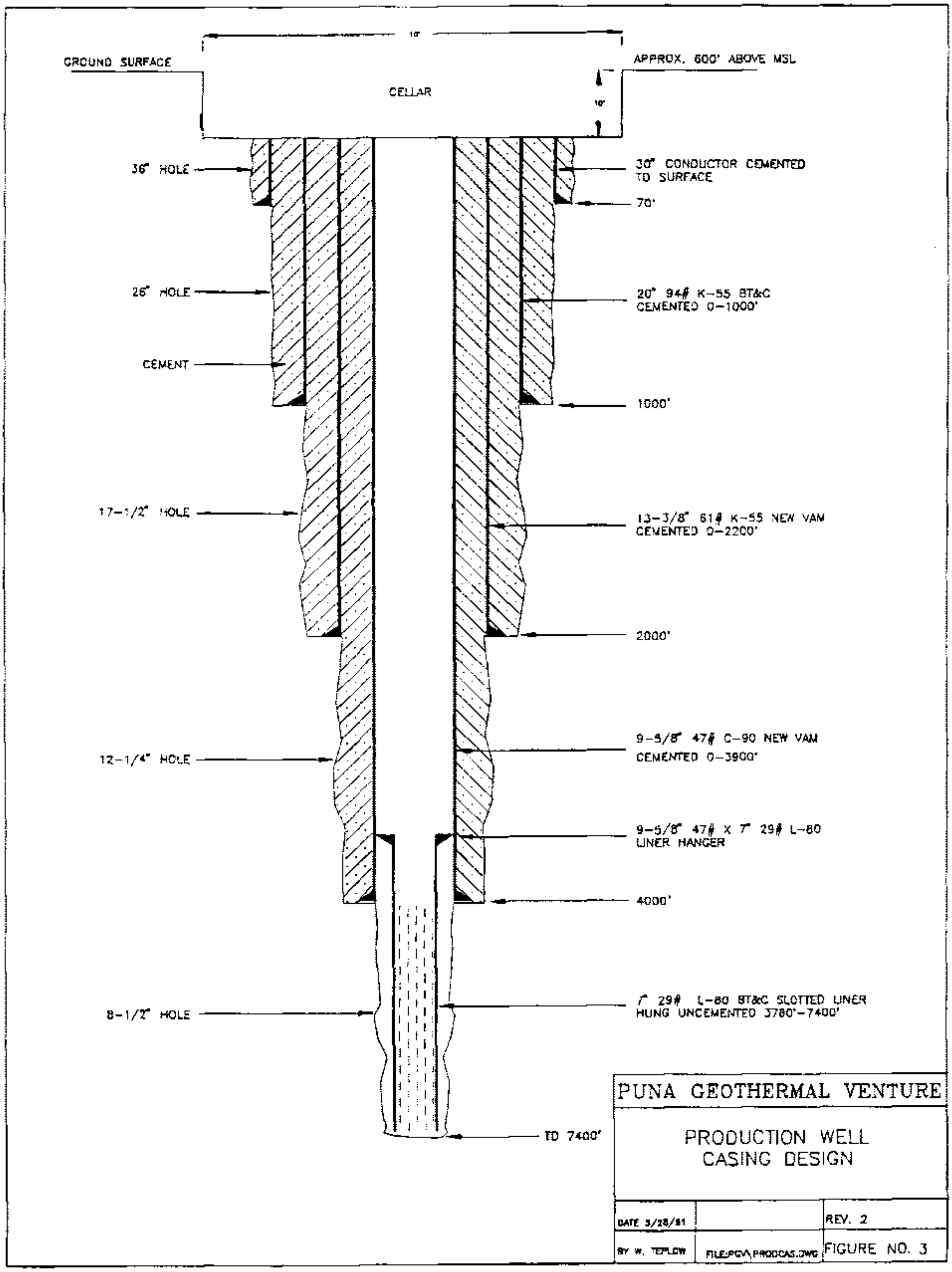


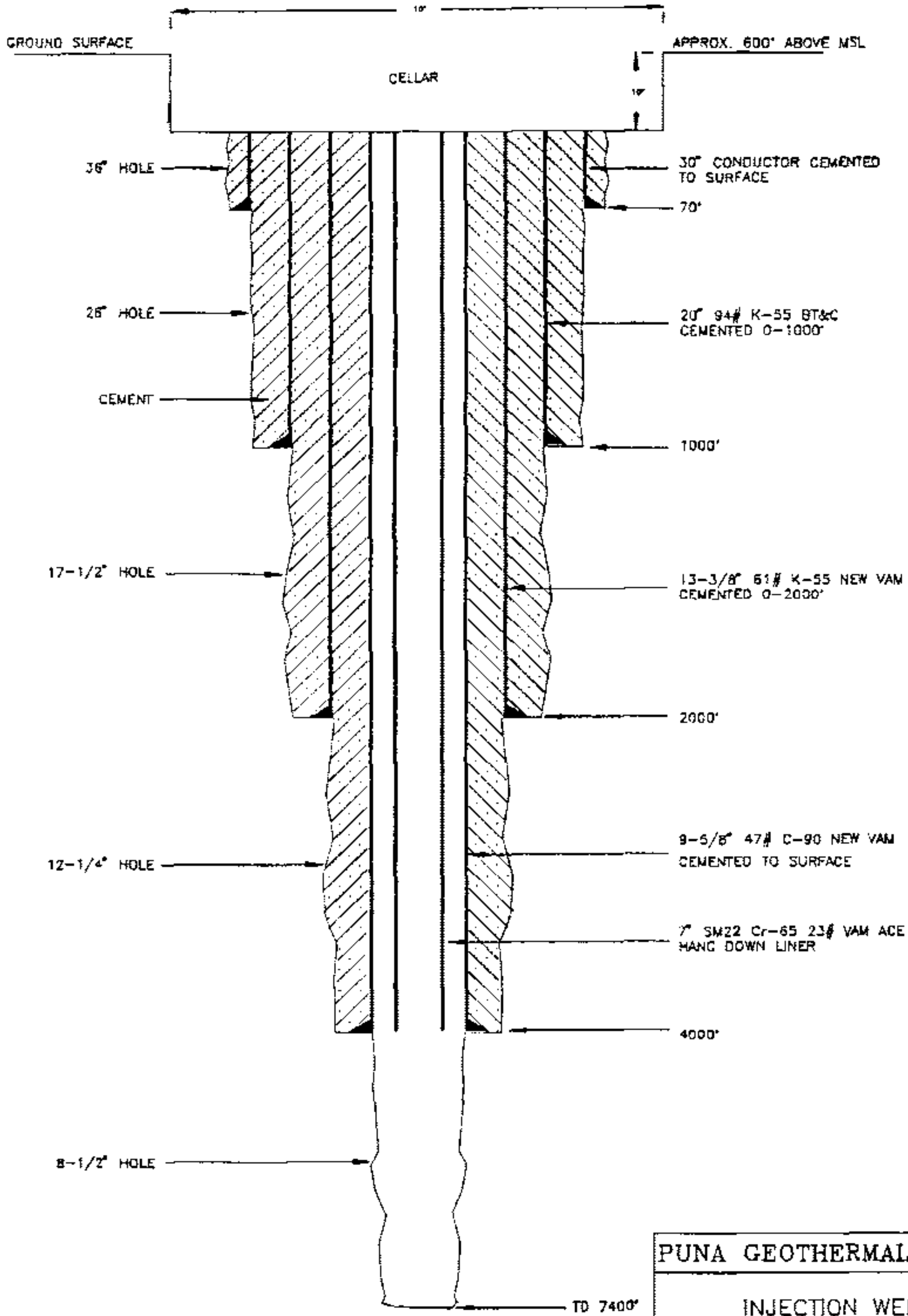
KAPOHO - PAHOA ROAD
TO PAHOA
EASEMENT B
MW-1
SOH-1
CORE HOLE
EASEMENT A
POWER
PLANT
KS-12
KS-13
KS2
WELL PAD B
KS-9
KS-10
KS1
KS1-A
PAD A
KS-8
KS-7A
PAD D
KS-4
KS-3
KS-5
PAD E
KS-7
PAD F
MONITORING WELL
MW-2
LANIPUNI
HGP-A SITE
TO POHOIKI
N
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
DATE 3/28/91
BY W. TEPLOW
pgv\dohmap.dwg
FIGURE 1

PUI GEOTHERMAL VENTUF
KS-3 STATIC AND FLOWING
TEMPERATURE PROFILES




FIGURE


10'
GROUND SURFACE
APPROX. 600' ABOVE MSL
CELLAR
10'
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# K-55 BT&C CEMENTED 0-1000'
CEMENT
1000'
17-1/2" HOLE
13-3/8" 61# K-55 NEW VAM CEMENTED 0-2200'
2000'
12-1/4" HOLE
9-5/8" 47# C-90 NEW VAM CEMENTED 0-3900'
9-5/8" 47# X 7" 29# L-80 LINER HANGER
4000'
8-1/2" HOLE
7" 29# L-80 BT&C SLOTTED LINER HUNG UNCEMENTED 3780'-7400'
TD 7400'
PUNA GEOTHERMAL VENTURE
PRODUCTION WELL CASING DESIGN
DATE 3/28/91
REV. 2
BY W. TEPLOW
FILE:PGV\PRODCAS.DWG
FIGURE NO. 3




| PUNA GEOTHERMAL VENTURE | | |
|---|---|---|
| INJECTION WELL CASING DESIGN | | |
| DATE 4/1/91 | File pgv\ks8cas.dwg | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 4 |

OD CONTROL & MINERAL RESOURCE NCH
Division of Water and Land Development



FROM: ______ DATE: ______ FILE IN: ______

| TO: | INITIAL: | |
|---|---|---|
| ___ | ___ | G. AKITA |
| ___ | ___ | L. Choo |
| ___ | ___ | T. Kam |
| ___ | ___ | H. Young |
| ___ | ___ | S. Yong |
| ___ | ___ | C.P. Chang |
| ___ | ___ | Y.F. Xu |
| ___ | ___ | T. Nakama |
| ___ | ___ | J. Swift |
| ___ | ___ | J. Florez |
| ___ | ___ | M. Tanouye |
| ___ | ___ | C. D'Araujo |
| ___ | ___ | M. TAGOMORI |
| ___ | ___ | L. Nanbu |
| ___ | ___ | L. CHANG |
| ___ | ___ | E. LAU |
| ___ | ___ | A. Monden |
| ___ | ___ | G. Miyashiro |
| ___ | ___ | D. Lee |

PLEASE:

___ See Me
___ Call
___ Review & Comment
___ Take Action
___ Investigate & Report
___ Draft Reply
___ Acknowledge Receipt
___ Type Draft
___ Type Final
___ Xerox ___ copies

FOR YOUR:

___ Approval
___ Signature
___ Information
___ File

REQUESTED BY:

______
DATE

REMARKS:

Please make a copy of this caving monitoring Program and file one each for KS-3 and KS-1A

# PRODUCTION AND INJECTION WELL CASING MONITORING PROGRAM

## 1. INTRODUCTION

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If the CBL is run in the 9-5/8" production casing it will be used only to determine cement tops or as a diagnostic tool. The logging results will not meet oil and gas standards for cement bond or cement compressive strength. This is due to two factors:

2.1.1 Because of the temperature limitations on logging tools, a well must be cooled by water injection during the logging operation. The resulting thermal contraction of the casing creates a temporary micro annulus between the casing and cement. Therefore, the log shows that no bond exists. This micro annulus is believed to seal after the well heats back up to the usual temperature. The micro annulus is usually so small that it would only be a problem with high pressure gas and would not provide a flow path for geothermal fluids.

2.1.2 The cement used in geothermal wells is relatively light weight, low compressive strength cement. Geothermal casing is usually cemented in place over its entire length and the cement used must be lightweight or the formation will fracture due to the hydrostatic pressure from the cement column. Fracturing and the resultant loss of circulation cause an incomplete primary cement job. Any secondary cementing procedure usually never approaches the quality of a successful primary cement job. All of the light weight cements available on the market produce relatively low compressive strengths when set. High compressive strengths are not required for geothermal wells because the casing is cemented over its entire length. This supports and protects the casing and seals off any possible flow in the annulus. This is unlike the common practice in oil and gas wells where casing is cemented only to seal off the zones of interest or fresh water zones. The main method of determining the competency of the casing cement job while drilling will be the surface indications of pressure and circulation returns during the cement job and the shoe leak-off test. If both of these are positive, the cement job has an extremely high probability of providing a good seal against the migration of production fluids.

## 2.2 Monitoring During Injection Testing

Upon completion of each production well an injection test may be performed to give an initial indication of reservoir permeability. The injection test consists of pumping relatively cool, fresh water into the wellbore at several controlled rates while monitoring downhole and wellhead pressure. Temperature-pressure-spinner (TPS) logs will normally be run during the test. These logs can be used to locate leaks in the casing by noting a sudden change in temperature with depth or a drop in flow velocity within the casing string. In the event that a loss of mechanical integrity is indicated during or after injection, one or more of the following diagnostic methods will be used to confirm the leak:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV.

## 2.3 Monitoring During Flow Testing

During flow testing of each production well, wellhead temperature and pressure along with steam and brine flow rate and chemistry are continuously monitored. After the initial 24 hours of flow, flow characteristics tend to be stable. Sudden changes in the wellhead pressure, temperature, brine/steam ratio, or brine chemistry during stabilized flow can be indicative of a loss of mechanical

integrity which is allowing cool water leakage into the wellbore.

Also during flow testing, TPS logs are periodically run. Leakage of cool water into the wellbore or loss of fluid to zones behind casing may be seen in the TPS logs run during or after shut-in. In the event that wellhead or logging data indicate a loss of mechanical integrity during the flow test, the well will be shut in and one or more of the following diagnostic methods will be used to confirm the leaks and locate it more precisely:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV

2.4 Monitoring During Production

Wellhead pressure and temperature will be monitored daily during normal production. Brine and steam chemistry will also be analyzed for each production well. Initially, samples will be taken weekly to establish a baseline geothermal fluid chemistry. The sampling frequency will then be reduced to monthly and quarterly as stabilization of the fluid chemistry is confirmed.

Casing failure causing leakage of cool ground water into the wellbore or loss of geothermal fluid to the formation may be manifested as a pressure and temperature drop at the wellhead. Fluid chemistry changes may also indicate ground water leakage. Wellhead pressure, temperature, and chemistry data will be reported to the DOH quarterly on a routine basis.

In the event that anomalous production parameters are observed, TPS survey(s) will be run with the well flowing. The TPS profiles will be used to determine whether the observed changes are due to changes in reservoir characteristics or are caused by a loss of mechanical integrity. In the event of a suspected loss of mechanical integrity, one or more of the following diagnostic methods will be used to confirm the leak and locate it more precisely:

- Temperature log while injecting
- Static temperature survey
- Casing inspection logs with multi-arm caliper and/or magnetic inspection tools
- Other applicable methods as determined by PGV

2.5 Casing Repair

Once a loss of mechanical integrity is identified and approximately located, casing repair procedures will be initiated. These procedures may include any or all of the following activities:

2.5.1 Shut in well and run magnetic and multi-arm casing inspection logging tools to precisely locate leak and to evaluate casing condition.

2.5.2 Rig up workover rig on well. Run packer(s) on drillpipe and pressure test to confirm suspected leaking interval.

2.5.3 Execute cement squeeze job to seal casing leak or stop interformational flows behind casing.

2.5.4 Perform casing pressure test and other diagnostic tests as necessary to confirm success of the remedial work. If good, move rig off well and return well to production.

2.5.5 In the event of major casing failure, a cemented liner may be installed through the damaged interval.

2.5.6 Prior to drilling out the liner shoe, the liner will be pressure tested as described in Section 2.1.

2.5.7 If mechanical integrity cannot be restored satisfactorily, the well will be plugged and abandoned.

## 3. INJECTION WELL CASING MONITORING PROGRAM

### 3.1 Pressure Testing During Drilling

The cemented casing string design in PGV injection wells (Figure 4) is similar to that of production wells. Testing of each string will proceed as described in 2.1 above.

### 3.2 Monitoring During Injection Testing

Prior to installation of the hangdown liner, an injection test will be performed to measure injectivity of the open formation below the cemented 9-5/8" casing. During the test, one or more of the following logs or surveys will be run:

- TPS through the open hole and cased intervals with the well on injection.
- Static temperature surveys to check for evidence of interformational flows behind casing.
- Other logs or surveys, as determined by PGV, to check for mechanical integrity of the casing and cement.

If the results of the logs and surveys confirm mechanical integrity, then the 7" hangdown liner may be installed. If leakage is found, repair procedures as described in 2.5 will be performed.

### 3.3 Monitoring During Routine Injection

During routine injection, the 7" x 9-5/8" annulus will be purged with nitrogen. Purge pressure and flow rate will be monitored for any changes indicative of a casing leak. Purge will be repeated as necessary to maintain the fluid level more than 1/2 way down the annulus. Once annually, tests and surveys will be conducted to verify mechanical integrity of the hangdown liner. The casing and hangdown liner will be tested for leaks by one of the following procedures, or a combination thereof:

3.3.1 Perform a pump-down test on the 7" x 9-5/8"

annulus. Nitrogen will be injected into the annulus to a pressure sufficient to displace the water level to the 9-5/8" casing shoe and shut in. Surface pressure on the annulus and hangdown liner will be monitored and recorded. Annulus pressure bleed-off exceeding 8% in 30 minutes will be considered indicative of a leak. If necessary, the pressure test will be extended beyond 30 minutes to preclude thermal effects on the surface pressure. In that case, the final 30 minutes will constitute the test period.

<u>or</u>

3.3.2 If the hangdown liner is pulled, the casing may be pressure tested above a bridge plug or packer set near the shoe following the basic procedure outlined in Section 2.1. Integrity of the hangdown liner may be verified by inspection on the surface, by a pressure test after it is run in the hole, or by a TPS log with the well on injection.

Integrity of the cement will be checked during each workover by one or more of the following procedures:

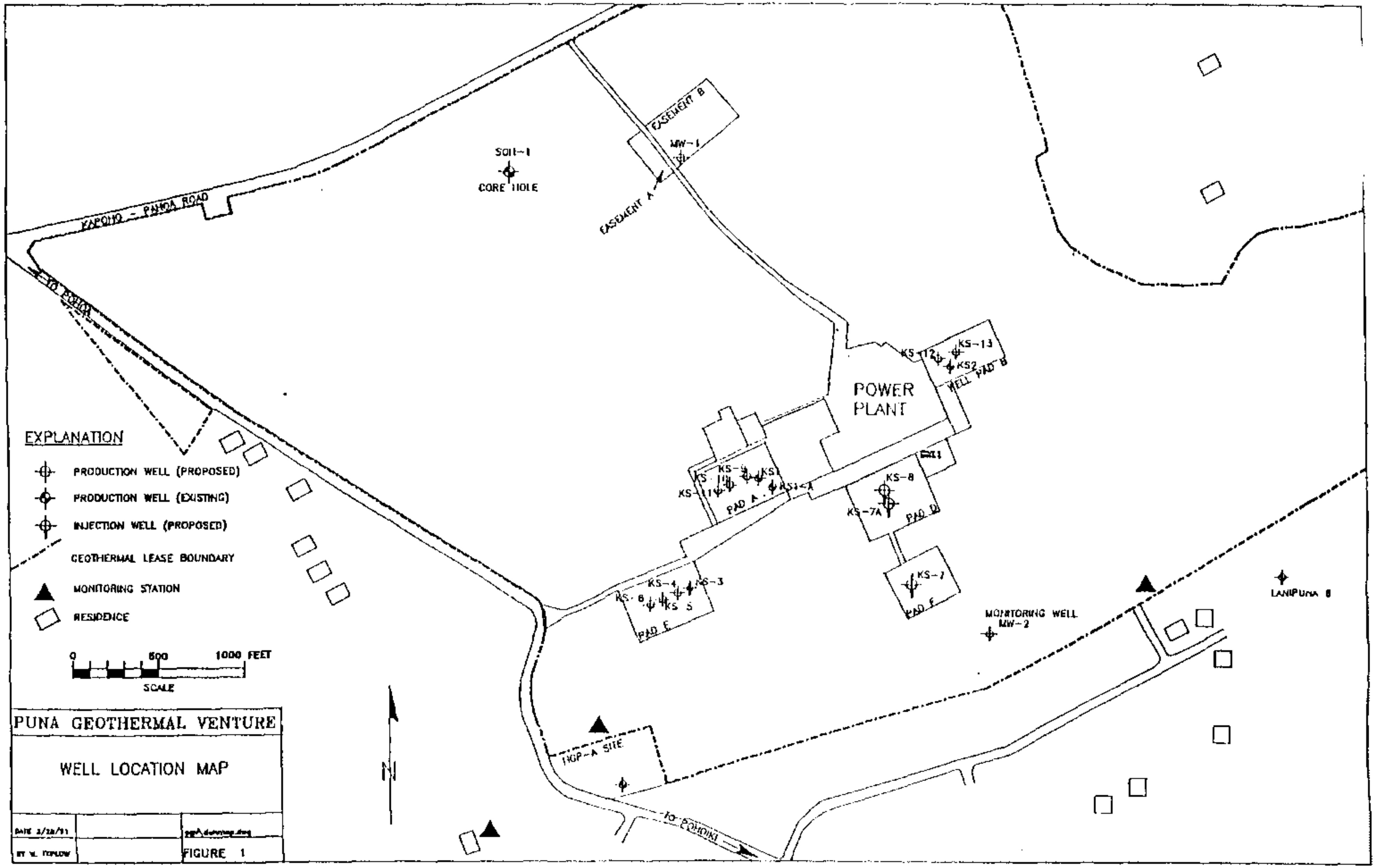
3.3.3 One or more shut-in static temperature surveys will be run. Shut-in time will be at least 12 hours, or longer if necessary to obtain meaningful results.

<u>or</u>

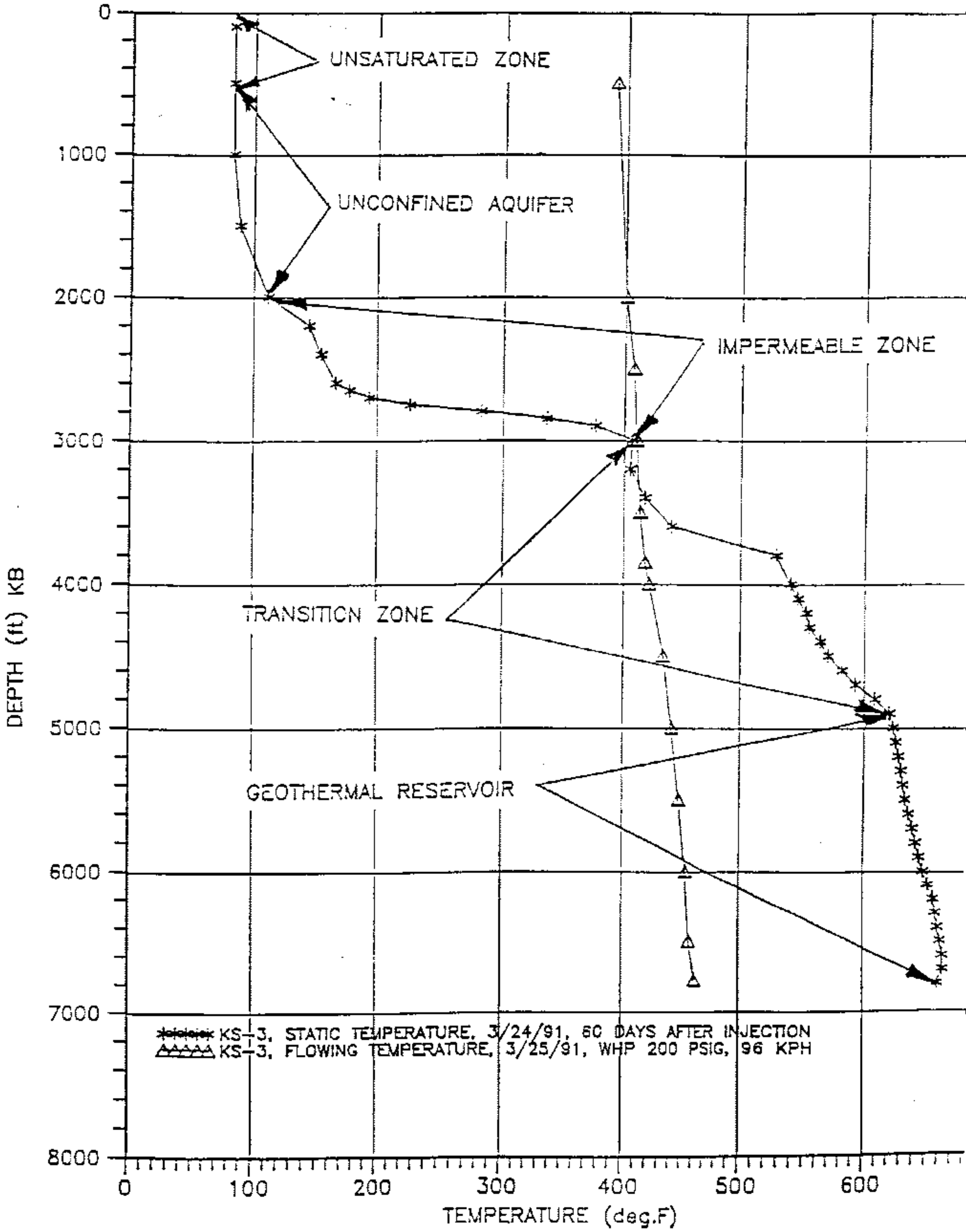
3.3.4 Other logs or surveys may be run, at the discretion of PGV, if static temperature surveys are not definitive.

### 3.4 Restoration of Mechanical Integrity or Abandonment

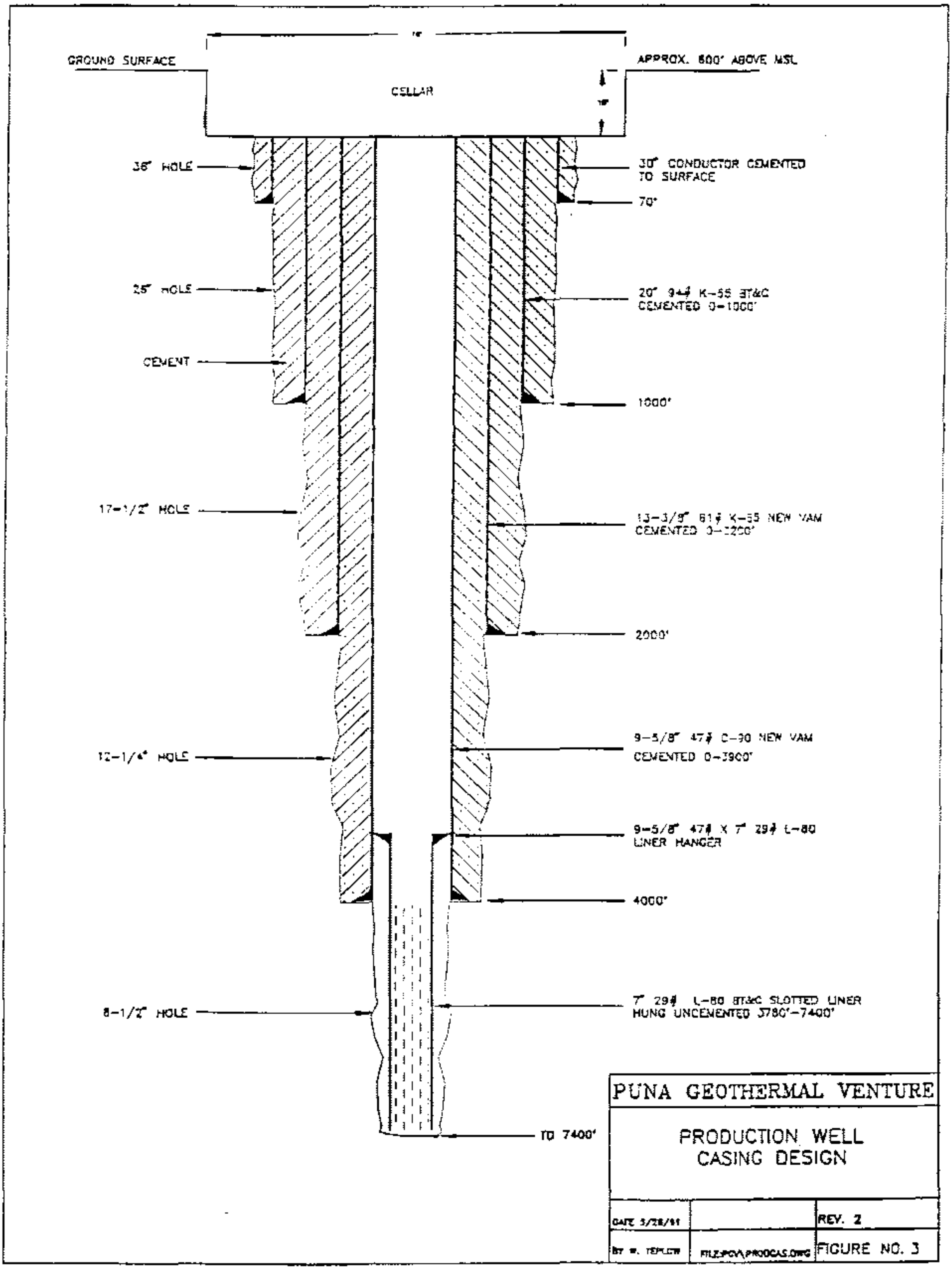
In the event that the diagnostic procedures indicate a loss of mechanical integrity, remedial or abandonment procedures will be carried out as specified in Section 2.5.

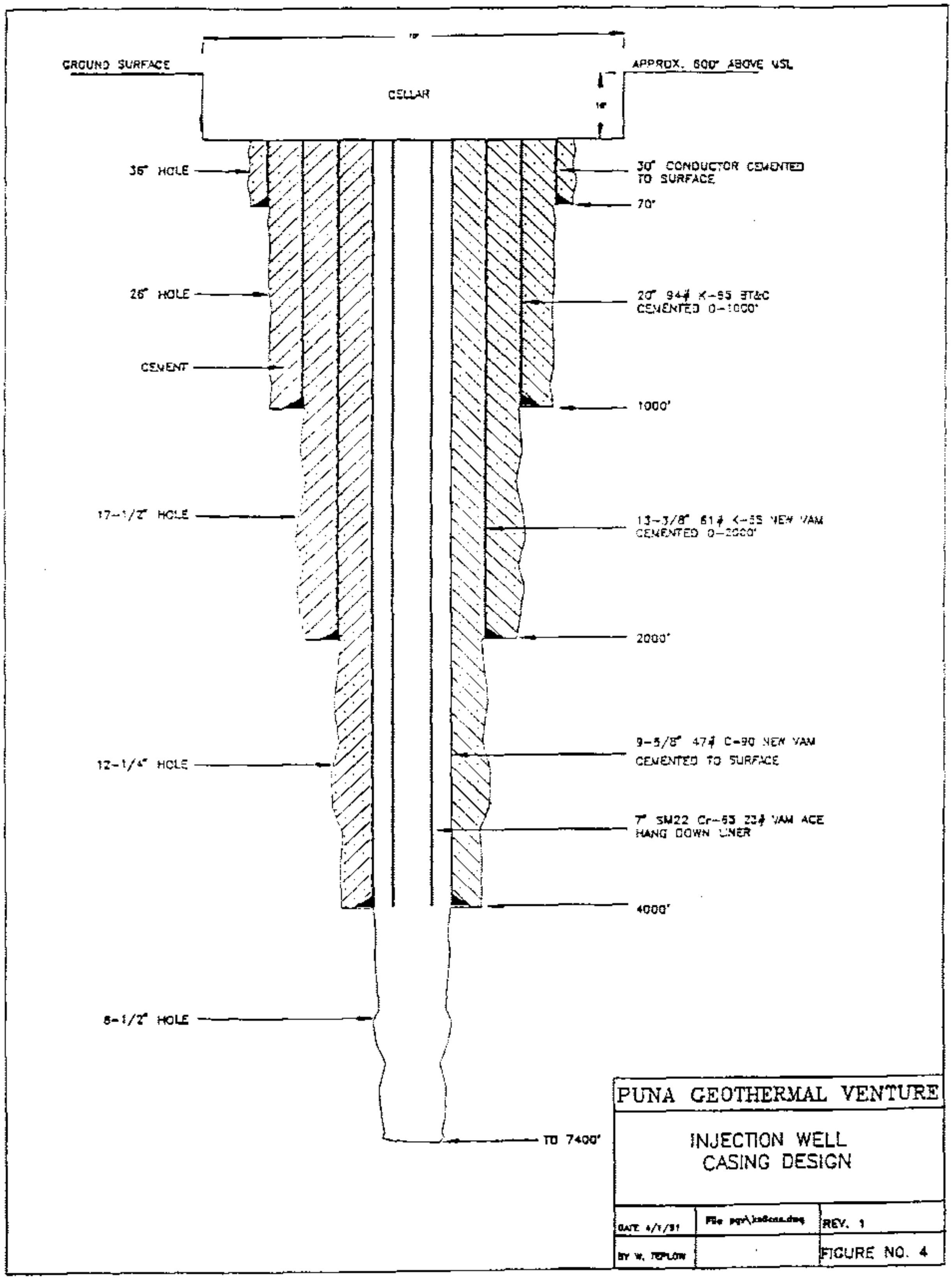

KAPOHO - PAHOA ROAD
TO PAHOA
SOIL-1
CORE HOLE
EASEMENT B
MW-1
EASEMENT A
POWER
PLANT
KS-12
KS-13
KS2
WELL PAD B
KS-8
KS-7A
PAD D
KS-7
PAD F
PAD A
KS-11
KS-9
KS-4
KS-3
KS-6
KS-5
PAD E
MONITORING WELL
MW-2
HGP-A SITE
TO POHOIKI
N
EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
FIGURE 1

PUNA GEOTHERMAL VENTURE
K -3 STATIC AND FLOWI
TEMPERATURE PROFILES




FIGURE


GROUND SURFACE
APPROX. 600' ABOVE MSL
CELLAR
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# K-55 BT&C CEMENTED 0-1000'
CEMENT
1000'
17-1/2" HOLE
13-3/8" 61# K-55 NEW VAM CEMENTED 0-1200'
2000'
12-1/4" HOLE
9-5/8" 47# C-90 NEW VAM CEMENTED 0-3900'
9-5/8" 47# X 7" 29# L-80 LINER HANGER
4000'
8-1/2" HOLE
7" 29# L-80 BT&C SLOTTED LINER HUNG UNCEMENTED 3780'-7400'
TD 7400'
PUNA GEOTHERMAL VENTURE
PRODUCTION WELL CASING DESIGN
DATE 3/28/91
REV. 2
BY W. TEPLOW
FILE:PGV\PRODCAS.DWG
FIGURE NO. 3



GROUND SURFACE
CELLAR
APPROX. 600' ABOVE MSL
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# K-55 BT&C CEMENTED 0-1000'
CEMENT
1000'
17-1/2" HOLE
13-3/8" 61# K-55 NEW VAM CEMENTED 0-2000'
2000'
12-1/4" HOLE
9-5/8" 47# C-90 NEW VAM CEMENTED TO SURFACE
7" SM22 Cr-65 23# VAM ACE HANG DOWN LINER
4000'
8-1/2" HOLE
TD 7400'
PUNA GEOTHERMAL VENTURE
INJECTION WELL CASING DESIGN
REV. 1
BY W. TEPLOW
FIGURE NO. 4

# PUNA GEOTHERMAL VENTURE - CONSTRUCTION

P.O. BOX 1337, HILO, HI 96721-1337
TEL: (808) 961-2786 FAX: (808) 965-7254

## FACSIMILE COVER PAGE

SENT TO: Harry Kim MSG #: 3778

ATTENTION: FAX #:

FROM: Bill Teplow DATE: 9/24/91

FILE #: CC: Mattey, Richard, Kizis, file

NUMBER OF PAGES (INCLUDING COVER SHEET): 1

IF YOU HAVE DIFFICULTIES RECEIVING THIS FAX PLEASE CALL
(808) 961-2786 ASK FOR: ________.

PGV DAILY DRILLING ACTIVITY SUMMARY

Date: 9/24/91
Time: 0800 hrs.

KS-8

Previous 24 hours activities:

Ran 200' of 7" casing and screwed into 7" liner at 2072'.

Planned activities for next 24 hours:

Run and cement 9-5/8" casing from 2072' to surface.

KS-1A

Previous 24 hours activities:

Killed well using Halliburton pump truck. Continued injecting water from water well to keep well on vacuum.

Planned activities for next 24 hours:

Maintain well on vacuum using well water.

# Hawaii County Civil Defense Agency

920 Ululani Street
Hilo, Hawaii 96720
TELEPHONE: 935-0031 FAX: 935-6460

## FACSIMILE COVER SHEET

| TO: | DEPARTMENT | ATTENTION | FAX NO. |
|---|---|---|---|
| | COUNTY: | | |
| | Corporation Counsel | Michael Matsukawa | 969-7049 |
| | | Glenn Shiigi | 969-7049 |
| | Office of the Mayor | Lorraine Inouye | 961-6553 |
| | | Barry Mizuno | 961-6553 |
| | Planning Department | Tad Nagasako | 961-9615 |
| | | Rodney Nakano | 961-9615 |
| | STATE: | | |
| | Dept. of Business & Economic Development | Gerald Lesperance | 586-2536 |
| | | Murray Towill | 586-2377 |
| | Dept. of Health | Dr. Bruce Anderson | 548-3263 |
| | | Clifford Furukado | 933-4669 |
| | | Jerry Haruno | 548-1173 |
| | | Harold Matsuura | 933-4669 |
| | | Wendell Sano | 543-8222 |
| | | Aaron Ueno | 933-4669 |
| | Dept. of Land & Natural Resources | Dean Nakano | 548-6052 |
| | | William Paty | 548-6461 |

FROM: Harry Kim, Administrator

DATE: Sept. 24, 1991

SUBJECT: Puna Geothermal Venture Daily Drilling Activity Summary for Sept. 24, 1991 on KS-8 Well

Fax consists of 2 pages, including this page. If there are any problems in receiving this fax, please contact Audrey or Dot at 935-0031.

TEL No. Sep 23,91 8:30 No.002 P.01

# PUNA GEOTHERMAL VENTURE - CONSTRUCTION

P.O. BOX 1337, HILO, HI 96721-1337
TEL: (808) 961-2786 FAX: (808) 965-7254

## FACSIMILE COVER PAGE

SENT TO: Harry Kim MSG #:

ATTENTION: FAX #:

FROM: Bill Teplow DATE: 9/23/91

FILE #: CC: MAR, Klaus, file

NUMBER OF PAGES (INCLUDING COVER SHEET): 1

IF YOU HAVE DIFFICULTIES RECEIVING THIS FAX PLEASE CALL
(808) 961-2786 ASK FOR:

PGV DAILY DRILLING ACTIVITY SUMMARY

Date: 9/23/91
Time: 0800 hrs.

KS-8

Previous 24 hours activities:

Cleaned 13-3/8" with casing scraper to 2071'. Milled inside 7" 2072'-2075'.

Planned activities for next 24 hours:

Run 6 joints of 7" casing, tie into 7" at 2072'.

KS-1A- Planned activities for next 24 hours:

Hook up Halliburton pump truck and kill well using water.

SEP 23 '91 09:11 CIVIL DEFENSE-HILO (808)935-6460 P.2/4

# *PUNA GEOTHERMAL VENTURE*

*A Hawaii Partnership*

RECEIVED

91 SEP 20 P 1:01

DIV. OF WATER & LAND DEVELOPMENT

September 16, 1991

Manabu Tagamori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Re: Request to kill well KS-1A.

Dear Mr. Tagamori:

Since August 1991, the wellhead pressure in KS-1A has been steadily increasing. The pressure is a result of both increased artesian pressure and development of a gas cap. The following pressure readings were made since August 1:

| Date | Pressure (psig) |
|---|---|
| 8/1/91 | 87 |
| 8/15/91 | 280 |
| 8/30/91 | 429 |
| 9/15/91 | 558 |

PGV is hereby requesting approval from your office to perform a kill operation on KS-1A in order to eliminate the artesian pressure and gas cap. The kill operation will consist of the following:

1. Rig up Halliburton pumping unit to 3" side valve on 9-5/8" wellhead. Connect Halliburton to drilling water line.
2. Pump water at a rate of 1/2-1 bpm until two wellbore volumes have been injected.
3. Increase flow rate as indicated by wellhead pressure. Periodically shut in pump and observe static wellhead pressure. Estimated time to kill well is 12 to 24 hours.
4. When well goes on vacuum, rig down Halliburton and rig up direct connection to drilling water supply. Inject water from drilling water supply line as needed to maintain well on a vacuum. Continue to monitor wellhead pressure daily.

14-3860 Kapoho Pahoa Road, Pahoa, Hawaii 96778 • (808) 961-2786 • Facsimile (808) 935-5562
Post Office Box 1337, Hilo, Hawaii 96721-1337

No gas emissions are expected to occur from this operation.

If you have any questions regarding this request, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

William J Teplow

William J. Teplow
Field Manager

cc: Dean Nakano
Eric Tanaka
Rodney Nakano
Norman Hayashi
Duey Milner
MAR
Tom Kizis
Bill Rickard

5 INCH HANGDOWN LINER:WELL KS-1A

5 INCH CASING TO BE RUN UTILIZING A CRANE

1. MOVE IN AND RIG UP EQUIPMENT FOR RUNNING A 5 INCH HANG DOWN LINER IN WELL KS-1A.

2. RIG UP OVER THE EXISTING WELLHEAD VALVE WITH A DOUBLE RAM BLOWOUT PREVENTER AND HYDRIL. TEST PREVENTER AND HYDRIL AGAINST THE WELLHEAD VALVE TO 1500 PSI. HAVE THE BOP TEST WITNESSED BY A REPRESENTATIVE OF DLNR.

3. INSTALL OVER THE TOP OF THE HYDRIL A WORKING PLATFORM SUITABLE FOR RUNNING TUBING AND CASING.

4. POSITION A 100 TON CRANE ON LOCATION SO THAT IT CAN PICK UP AND RUN IN THE HOLE 3 1/2 INCH DRILL PIPE AND 5 INCH CASING. IT MAY BE NECESSARY TO HAVE A SMALLER CRANE ON LOCATION TO PICK UP PIPE AND THE 150 TON CRANE SO POSITIONED THAT ITS ONLY FUNCTION WILL BE TO RUN PIPE IN AND OUT OF THE WELL. THE TOTAL WEIGHT OF THE 5 INCH STRING IN AIR WILL BE 91000 LBS.

5. KILL WELL WITH WATER AND KEEP DEAD.

   5A. PICK UP RTTS TOOL AND RUN IN HOLE WITH 3-1/2 INCH DRILL PIPE TO A DEPTH SUFFICIENT TO SET THE RTTS INSIDE THE 7 INCH CASING. RUN RTTS WITH SUB SEA VALVE INSTALLED AND BOPE ON TOP OF DRILL PIPE. PRESSURE TEST AGAINST THE RTTS TOOL TO 2000 PSI.

   5B. KEEP WELL DEAD WITH WATER THROUGH 3-1/2 INCH DRILL PIPE AND RTTS.

6. NIPPLE DOWN BOPE AND MASTER VALVE; REMOVE WORK PLATFORM.

   6A. CLOSE DRILL PIPE BOP AND DISCONTINUE INJECTION. STRIP BOPE AND MASTER VALVE OFF OF EXPANSION SPOOL OVER THE 3-1/2 INCH DRILL PIPE.

   6B. STRIP 8 INCH HANGER SPOOL, MASTER VALVE AND BOPE ON TO EXPANSION SPOOL. RESUME WATER INJECTION THROUGH 3-1/2 INCH DRILL PIPE TO KEEP WELL DEAD.

   6C. NIPPLE UP HANGER SPOOL, MASTER VALVE AND BOPE.

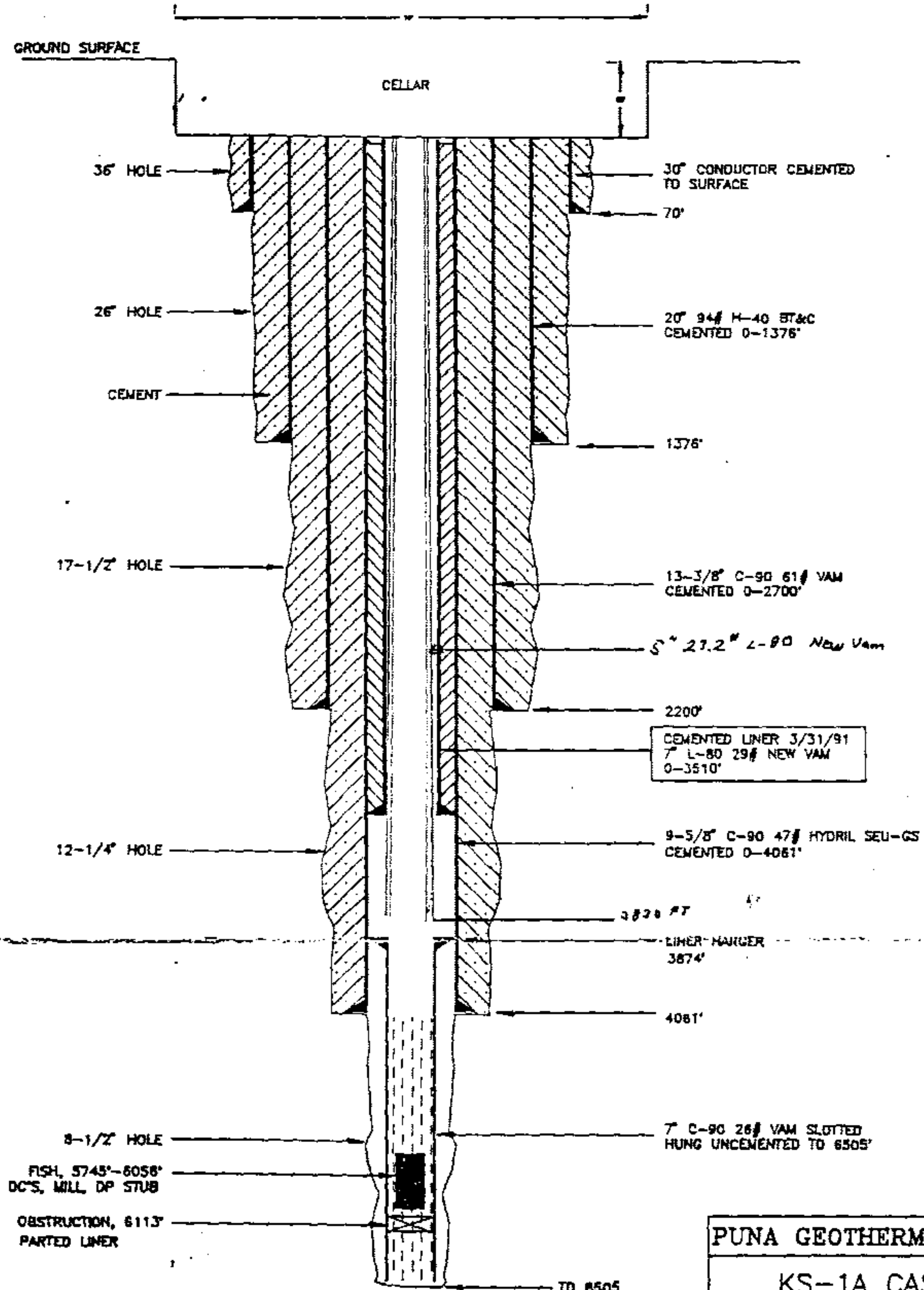
   6D. REINSTALL WORK PLATFORM.

7. PRESSURE CHECK BOP'S, MASTER VALVE, AND NEWLY INSTALLED LINER HANGER TO 2000 PSI. HAVE THE TEST OF BOP EQUIPMENT WITNESSED BY DLNR REPRESENTATIVE.

8. RETRIEVE RTTS TOOL FROM 7 INCH CASING. PULL OUT OF HOLE LAYING DOWN 3-1/2 INCH DRILL PIPE. SHUT DOWN OPERATIONS UNTIL MORNING, KEEP WELL DEAD BY PUMPING COLD WATER.

9. RIG UP TO RUN 5 INCH CASING. KEEP WELL DEAD BY PUMPING COLD WATER. CASING IS TO BE RUN WITH A CRANE UTILIZING A CASING CREW TO MAKE UP AND RUN THE CASING. THE CASING WILL BE RUN KEEPING THE WELL DEAD BY CONTINUALLY PUMPING COLD WATER INTO THE WELL THROUGH THE 3 INCH WING VALVES ON THE 9 5/8 INCH EXPANSION SPOOL. RIG UP AND RUN 3730 FT. OF 5 INCH, 23.20#/FT, L-80, NEW VAM CASING. HANG CASING IN DONUT ON 8 INCH BY 5 INCH DONUT HANGER USING 5 INCH DRILL PIPE TO LAND DONUT. BACK OFF DRILL PIPE FROM LINER HANGING DONUT AND SECURE LINER HANGER IN SPOOL WITH LOCK DOWN NUTS.

10. RIG UP AN AIR COMPRESSOR TO THE 5 INCH BY 7 INCH ANNULUS AND PRESSURIZE THE ANNULUS WITH AIR TO THE SHOE OF THE 5 INCH CASING. OBSERVE THE ANNULUS PRESSURE FOR LEAKS, ONCE THE ANNULUS IS SECURED, NIPPLE DOWN BOPE AND WORK PLATFORM RELEASE CRANE AND CREWS FROM LOCATION.




| PUNA GEOTHERMAL VENTURE | |
|---|---|
| KS-1A CASING SCHEMATIC AFTER REWORK | |
| DATE 5/13/91 | REV. 1 |
| BY W. TEPLOW | FIGURE NO. 4 |

Lwm

1242

ORMAT®

March 4, 1991

Mr. William Paty
Chairperson
Board of Land and Natural Resources
Division of Land Management
P.O. Box 621
Honolulu, HI 96709

Dear Sir,

In accordance with Condition 23 of the letter of October 23, 1989 from the Planning Commission of the County of Hawaii, regarding Geothermal Resource Permit for the Puna Geothermal Project, please accept this letter as notification of commencement of drilling activities described as follows:

- The reworking of existing well KS1A will commence on or after March 18, 1991. Similar equipment as utilized on previous drilling operations on site will be used.

Should you wish to receive future notifications in advance of open venting of each geothermal well, pipeline cleanouts, and commencement of drilling of additional wells, please forward your request to be placed on the Notification List to:

Puna Geothermal Venture Construction
P.O. Box 1337
Hilo, HI 96721-1337

Attn: Permit Notification Coordinator

I assume we are on this list

Note: Agencies and those individuals having previously requested to be placed on the Notification List need make no further request.

Respectfully,

Norman J. Clark
Project Manager
Puna Geothermal Venture

PUNA GEOTHERMAL VENTURE CONSTRUCTION

P.O. Box 1337 • Hilo, Hawaii 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

RECEIVED

90 SEP 18 A8:39

DIV. OF WATER &
LAND DEVELOPMENT

ORMAT®

September 14, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Request for Modification of Geothermal Production Well KS-1A, Puna Geothermal Venture.

Dear Mr. Tagomori:

Puna Geothermal Venture (PGV) is proposing to modify the casing and wellhead of geothermal production well KS-1A. PGV is hereby seeking approval from your office for this Request for Modification. The purpose of the modification is to strengthen the production casing string, eliminate possible casing leaks, and repair damage to the 9-5/8" casing within the the expansion spool. This will assure good casing integrity when KS-1A is placed in service as a production well.

The proposed work will consist of running a string of 7" cemented production liner from the surface to a depth of 3540'. Also, the 13-3/8" casing head will be replaced with a 9-5/8" casing head and 7" explansion spool. This proposed work is described in detail in the attached workover program.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 HILO, HAWAII 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

*PUNA GEOTHERMAL VENTURE*

KS-1A REWORK AND WELLHEAD REPAIR

1. Move rig over well.

2. Remove top 10" valve. Install API 3000# double gate BOP and annular preventer on top of 10" master valve.

3. Run drill pipe to top of cement plug (3500') and circulate well with cold water 4 hrs or until return temperature is stable. Start pumping at 1 barrel per minute to avoid thermal shocking well casing.

4. Mix 20 cubic feet (50 Linear feet) geothermal cement (type II with 40% silica flour) and spot on top of existing plug. W.O.C. 6 hours.

5. Remove BOP, wellhead valve and 13 3/8" x 9 5/8" expansion spool. Remove 13 3/8" x 20" expansion spool. Cut off 20" casing at floor of cellar. If no cement in 30" x 20" annulus run 1" tubing to top of cement and blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

6. Cut-off 13 3/8" casing 10' below surface. Run 1" pipe in 20" x 13 3/8" annulus to top of cement. Blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

7. Cut-off 9 5/8" casing 8' below surface and dress for welding. Center 9 5/8" casing inside 13 3/8" casing. Run 1" pipe in 13 3/8" x 9 5/8" annulus to top of cement. Blow annulus dry with air. Mix geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

8. Weld API 3000# casing head on 9 5/8" casing. Assemble double gate BOP and annular preventer on casing head.

9. Pressure test casing to 500 psi and hold for 10 minutes.

10. It pressure bleeds-off, conduct injection test and spinner survey to locate source of leak.

11. Run drill pipe to leak and circulate water 4 hours. Mix 40 cubic feet geothermal cement and place opposite leak through drill pipe, pull up 2 stands and squeeze. W.O.C. 6 hrs.

12. Run in with 8 1/2" bit and drill cement.

13. Repeat pressure test. Repeat squeeze if test fails.

14. Run drill pipe to 3400 feet and blow well dry with air.

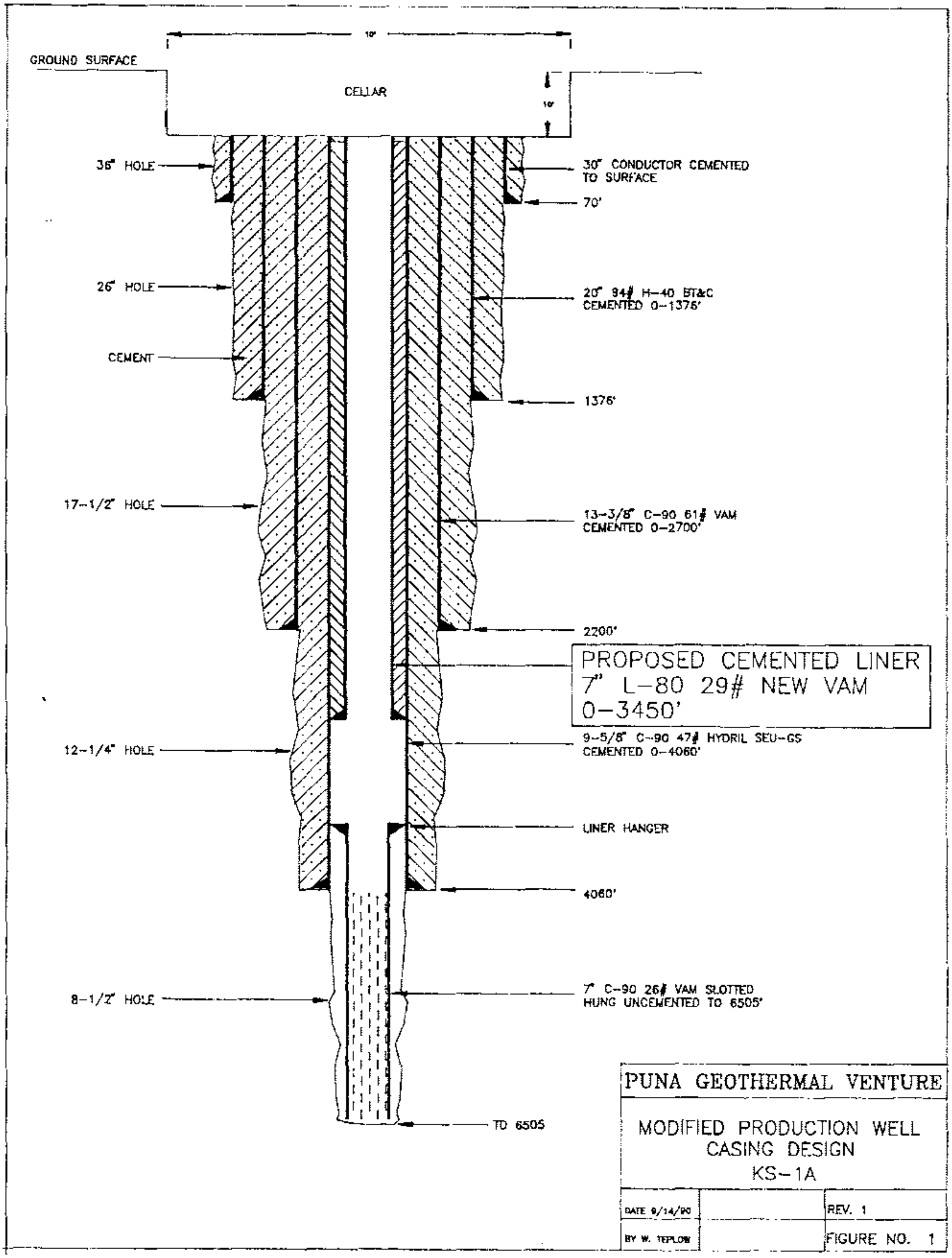
15. Run 3450 feet 7", L80, 29#, New Vam casing with centralizers on bottom three joints and 5th joint from surface. Cement to surface with 500 cubic feet geothermal cement (type II + 40% silica flour + 0.65% CFR-3). After plug is bumped unbolt and raise BOP at casing head flange. Set 7" casing alignment bowl. W.O.C. 12 hours.

16. Install API 3000# 9 5/8" x 7" expansion spool and pack-off. Install 8" ANSI 900 wellhead valve. Reassemble double gate BOP and annular preventer.

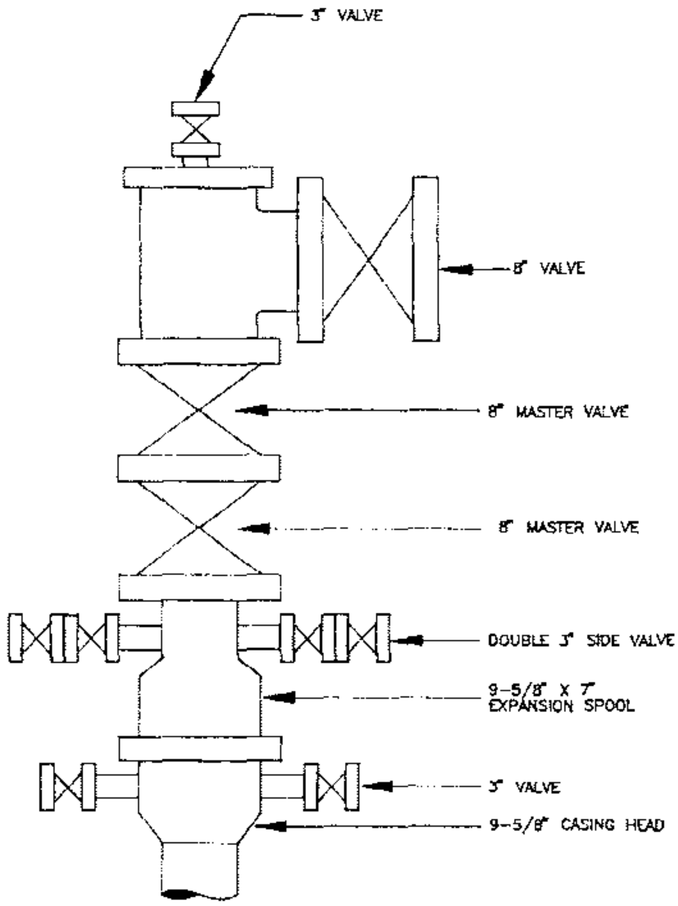
17. Run 6" bit and drill out cement plug with water. Run bit to top of 7" liner.

18. POOH laying down drill pipe. Remove BOP and install second 8" ANSI 900 wellhead valve.

19. Allow well to warm approximately 15 days. Install flowline to storage pit and flow well approximately 30 minutes to clean.



10'
GROUND SURFACE
CELLAR
10'
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# H-40 BT&C CEMENTED 0-1376'
CEMENT
1376'
17-1/2" HOLE
13-3/8" C-90 61# VAM CEMENTED 0-2700'
2200'
PROPOSED CEMENTED LINER
7" L-80 29# NEW VAM
0-3450'
12-1/4" HOLE
9-5/8" C-90 47# HYDRIL SEU-GS CEMENTED 0-4060'
LINER HANGER
4060'
8-1/2" HOLE
7" C-90 26# VAM SLOTTED HUNG UNCEMENTED TO 6505'
TD 6505
PUNA GEOTHERMAL VENTURE
MODIFIED PRODUCTION WELL
CASING DESIGN
KS-1A
DATE 9/14/90
REV. 1
BY W. TEPLOW
FIGURE NO. 1




PUNA GEOTHERMAL VENTURE

MODIFIED WELLHEAD
CONFIGURATION
PRODUCTION WELL KS-1A

| | | |
|---|---|---|
| DATE 9/14/90 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 2 |

ORMAT®

Dr. John Lewin, M.D.
Director
State of Hawaii
Department of Health
P.O. Box 3378
Honolulu, Hawaii 96801

March 3, 1991

Re: Notification of Intent to Rework Well KS-1A

Dear Dr. Lewin:

Pursuant to Special Condition No. 2 of the Authority to Construct No. A-833-795, we are hereby giving notification to the Department of Health (DOH) for approval of the rework of production well KS-1A. It is anticipated that the rework of KS-1A will start on or shortly after March 15, 1991. KS-1A will be reworked using Parker Rig #231 which is currently drilling KS-7. This notification includes a map (Figure 1) which shows the well in relation to the property boundary, nearest residence, access roads, and the monitoring stations. Copies of the permit application and permit issued by DLNR for this rework are attached.

Also included in this notification is a status report for the previously constructed wells KS-1, KS-2, KS-1A, KS-3, KS-7, MW-1, and MW-2 as required under Special Condition No. 2.

If you have any questions that may assist in your review and approval, please do not hesitate to contact me.

Respectfully,
PUNA GEOTHERMAL VENTURE

William Teplow

William Teplow
Field Manager

cc: Chauncey Hew
N. Clark
T. Crowson
MAR
File

attachments:

PUNA GEOTHERMAL VENTURE CONSTRUCTION

P.O. Box 1337 • Hilo, Hawaii 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

ORMAT®

September 14, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 521
Honolulu, Hawaii 96809

Re: Request for Modification of Geothermal Production Well KS-1A, Puna Geothermal Venture.

Dear Mr. Tagomori:

Puna Geothermal Venture (PGV) is proposing to modify the casing and wellhead of geothermal production well KS-1A. PGV is hereby requesting approval for this Request for Modification. The purpose of the modification is to strengthen the production casing string, eliminate possible casing leaks, and repair damage to the 9-5/8" casing within the the expansion spool. This will assure good casing integrity when KS-1A is placed in service as a production well.

The proposed work will consist of running a string of 7" cemented production liner from the surface to a depth of 3540'. Also, the 13-3/8" casing head will be replaced with a 9-5/8" casing head and 7" exp ansion spool. This proposed work is described in detail in the attached workover program.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 Hilo, Hawaii 96721-1337
~~99 Aupuni Street #114~~ • ~~Hilo, Hawaii 96720~~ • Telephone (808) 961-2786 • Facsimile (808) 935-55

*PUNA GEOTHERMAL VENTURE*

## KS-1A REWORK AND WELLHEAD REPAIR

1. Move rig over well.

2. Remove top 10" valve. Install API 3000# double gate BOP and annular preventer on top of 10" master valve.

3. Run drill pipe to top of cement plug (3500') and circulate well with cold water 4 hrs or until return temperature is stable. Start pumping at 1 barrel per minute to avoid thermal shocking well casing.

4. Mix 20 cubic feet (50 linear feet) geothermal cement (type II with 40% silica flour) and spot on top of existing plug. W.O.C. 6 hours.

5. Remove BOP, wellhead valve and 13 3/8" x 9 5/8" expansion spool. Remove 13 3/8" x 20" expansion spool. Cut off 20" casing at floor of cellar. If no cement in 30" x 20" annulus run 1" tubing to top of cement and blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

6. Cut-off 13 3/8" casing 10' below surface. Run 1" pipe in 20" x 13 3/8" annulus to top of cement. Blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

7. Cut-off 9 5/8" casing 8' below surface and dress for welding. Center 9 5/8" casing inside 13 3/8" casing. Run 1" pipe in 13 3/8" x 9 5/8" annulus to top of cement. Blow annulus dry with air. Mix geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

8. Weld API 3000# casing head on 9 5/8" casing. Assemble double gate BOP and annular preventer on casing head.

9. Pressure test casing to 500 psi and hold for 10 minutes.

10. If pressure bleeds-off, conduct injection test and spinner survey to locate source of leak.

11. Run drill pipe to leak and circulate water 4 hours. Mix 40 cubic feet geothermal cement and place opposite leak through drill pipe, pull up 2 stands and squeeze. W.O.C. 6 hrs.

*PUNA GEOTHERMAL VENTURE*

12. Run in with 8 1/2" bit and drill cement.

13. Repeat pressure test. Repeat squeeze if test fails.

14. Run drill pipe to 3400 feet and blow well dry with air.

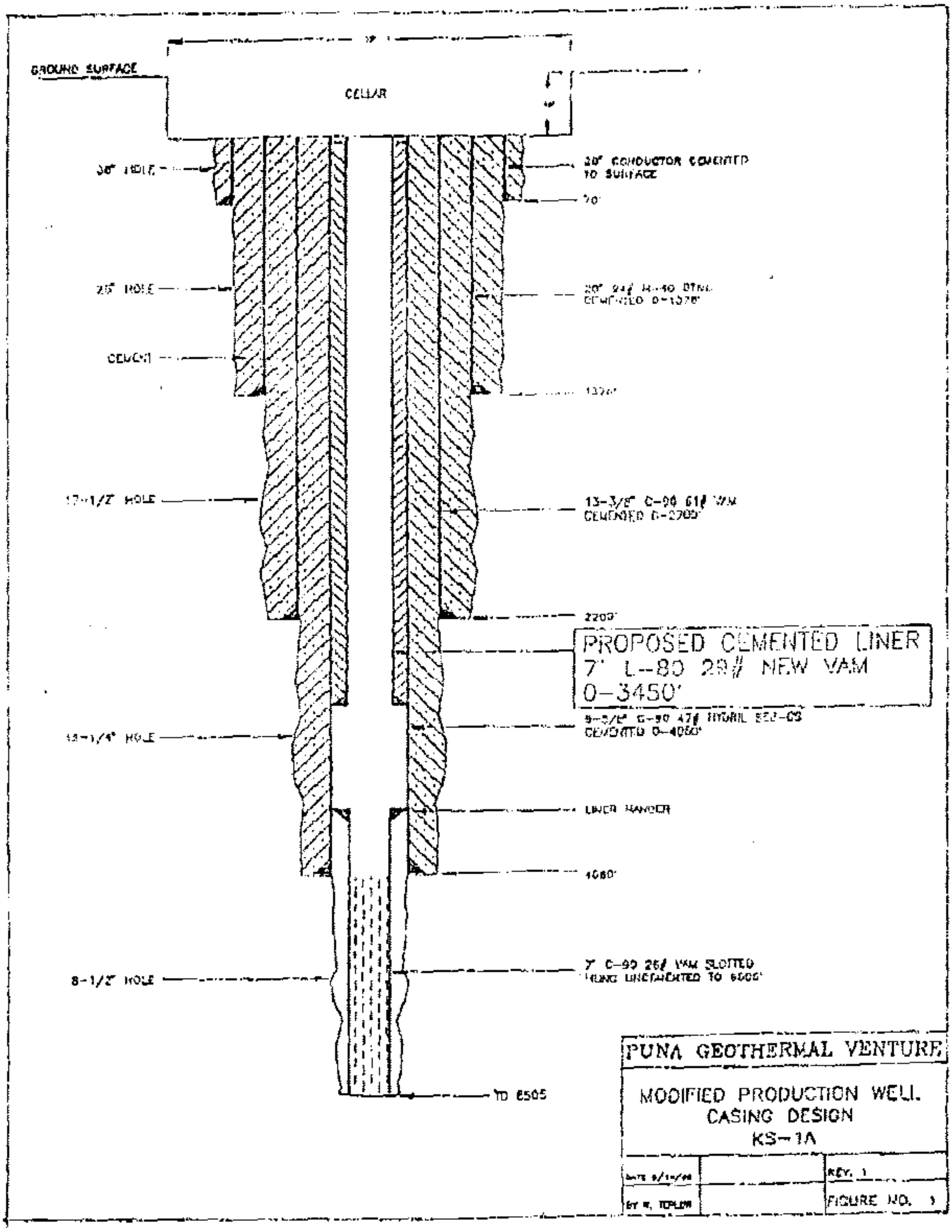
15. Run 3450 feet 7", L80, 29#, New Vam casing with centralizers on bottom three joints and 5th joint from surface. Cement to surface with 500 cubic feet geothermal cement (type II + 40% silica flour + 0.65% CFR-3). After plug is bumped unbolt and raise BOP at casing head flange. Set 7" casing alignment bowl. W.O.C. 12 hours.

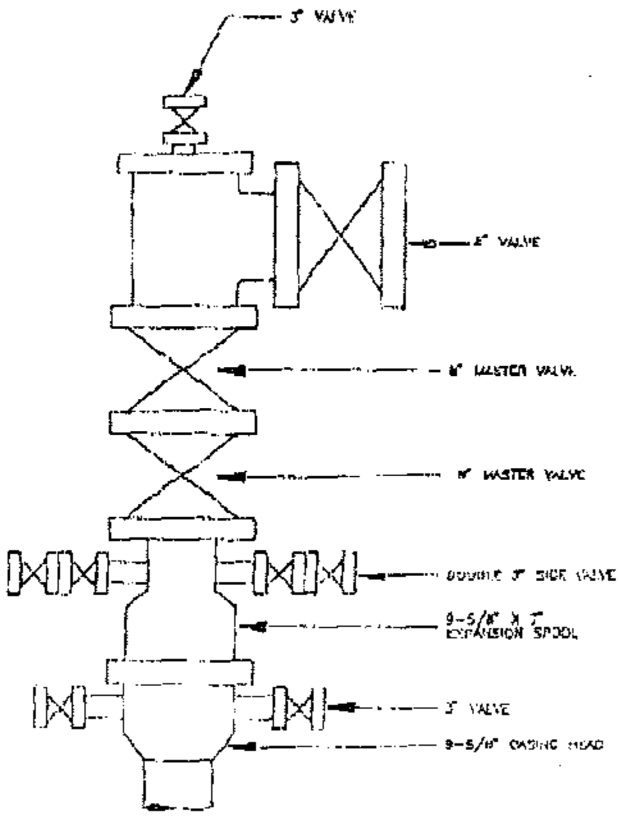
16. Install API 3000# 9 5/8" x 7" expansion spool and pack-off. Install 8" ANSI 900 wellhead valve. Reassemble double gate BOP and annular preventer.

17. Run 6" bit and drill out cement plug with water. Run bit to top of 7" liner.

18. POOH laying down drill pipe. Remove BOP and install second 8" ANSI 900 wellhead valve.

19. Allow well to warm approximately 15 days. Install flowline to storage pit and flow well approximately 30 minutes to clean.


GROUND SURFACE
CELLAR
28" CONDUCTOR CEMENTED TO SURFACE
70'
17-1/2" HOLE
13-3/8" C-90 61# VAM CEMENTED 0-2700'
2200'
PROPOSED CEMENTED LINER
7' L-80 29# NEW VAM
0-3450'
LINER HANGER
4060'
8-1/2" HOLE
7" C-90 26# VAM SLOTTED HUNG UNCEMENTED TO 6000'
TD 6505
PUNA GEOTHERMAL VENTURE
MODIFIED PRODUCTION WELL
CASING DESIGN
KS-1A
REV. 1
FIGURE NO. 1




PUNA GEOTHERMAL VENTURE

MODIFIED WELLHEAD
CONFIGURATION
PRODUCTION WELL KS-1A

| | | |
|---|---|---|
| DATE | | REV. 1 |
| BY | | FIGURE NO. 2 |

JOHN WAIHEE
GOVERNOR OF HAWAII

WILLIAM W. PATY, CHAIRPERSON
BOARD OF LAND AND NATURAL RESOURCES

DEPUTIES
KEITH W. AHUE
MANABU TAGOMORI
RUSSELL N. FUKUMOTO

AQUACULTURE DEVELOPMENT PROGRAM
AQUATIC RESOURCES
CONSERVATION AND ENVIRONMENTAL AFFAIRS
CONSERVATION AND RESOURCES ENFORCEMENT
CONVEYANCES
FORESTRY AND WILDLIFE
LAND MANAGEMENT
STATE PARKS
WATER AND LAND DEVELOPMENT

STATE OF HAWAII
DEPARTMENT OF LAND AND NATURAL RESOURCES
P. O. BOX 621
HONOLULU, HAWAII 96809

OCT 15 1990

REF:WRM-MH

# GEOTHERMAL WELL MODIFICATION PERMIT

Kapoho State No. 1-A

RECEIVED OCT 15 1990 PUNA GEOTHERMAL VENTURE

TO: Puna Geothermal Venture
P.O. Box 1337
Hilo, Hawaii 96721-1337

Your application dated September 14, 1990 for a permit to modify Geothermal Well Kapoho State No. 1-A is approved:

Well Designation: Kapoho State No. 1-A (KS-1A)
Location: TMK: 1-4-01:02, Kapoho, Puna, Hawaii
Leased to: Kapoho Land Partnership
Subleased to: Puna Geothermal Venture
Operator: AMOR VII Corporation
Ground Elevation: 620 ft. ±
Total Depth: 6,505 feet

You are hereby granted permission to modify Geothermal Well KS-1A by installing a seven-inch production liner and replacing the casing/wellhead assembly. Modification of the well shall be completed in accordance with the approved modification plans and the following conditions:

(1) All work shall be performed in compliance with the Department's Administrative Rules (Chapters 13-183 and 13-184), and all other applicable Federal, State, and County laws, ordinances, and regulations.

(2) The applicant, its successors and assigns shall indemnify and hold the State of Hawaii harmless from and against any loss, liability, claim or demand for property damage, personal injury and death arising out of any act or omission of the applicant, assigns, officers, employees, contractors and agents under this permit or relating to or connected with the granting of this permit.

(3) The applicant shall notify the Division of Water Resource Management, in writing, of the date for the start of work.

(4) Class "G" cement shall be used in the casing cementing operations and shall contain a high temperature resistant admix.

(5) All Blow-out Prevention Equipment (BOPE) and cemented casing strings shall be pressure tested before commencing any other operations on the well. Test pressures shall not be less than 600 pounds per square inch nor greater than 1,500 pounds per square inch, and shall be applied for a period of thirty minutes.

(6) If a drop of more than ten percent of the casing test pressure is recorded the operator shall then run a caliper log and/or other appropriate well test to evaluate if the casing is defective and if corrective measures will be required before commencing any further operations.

(7) The Department's representative shall be notified with reasonable time allowed for travel to the site to witness the required casing test. The results of the prescribed casing tests, shall be reported on forms provided by the Department and submitted for review no later than sixty days (60) after completion.

(8) A well completion report and an as-built drawing of the well shall be filed with the Department within six (6) months after completion of the well modification.

(9) The applicant shall obtain the Chairperson's approval prior to the execution of any contemplated changes in the modification program.

(10) The applicant shall submit to the Chairperson, the results of any exploration, all drilling and testing records, date of completion, and a survey of the well location and elevation by a Hawaii licensed surveyor within six months after completion of the well modification.

(11) During the use of the well for testing, monitoring, production and/or injection purposes, the well and site shall be properly maintained until the well is properly plugged and abandoned in accordance with Chapter 13-183, HAR.

(12) The bond covering the well shall remain in full force and effect until the well is properly abandoned and the surface is restored as near as possible to the original condition after operations are completed.

(13) The permit shall expire 365 days from the date of issuance.

WILLIAM W. PATY, Chairperson
Board of Land and Natural Resources

OCT 15 1990

Date of Issuance

cc: Land Board Members
Hawaii County Planning Dept.
Dept. of Business & Economic Development
Department of Health
Office of Environmental Quality Control

State of Hawaii
Department of Land and Natural Resources
Division of Water Resource Management

## CASING PRESSURE TEST

*Instructions:* Please print or type and send completed form with any attachments to Division of Water Resource Management, P.O. Box 373, Honolulu, Hawaii 96809

*Reference DLNR Regulations:*

§13-183-76 (b) All casing strings shall be pressure tested after cementing and before commencing any other operations on the well. Minimum casing test pressure shall be approximately one-third of the manufacturer's rated internal yield pressure; provided that the test pressure shall not be less than six hundred pounds per square inch and greater than 1500 pounds per square inch. In cases where combination strings are involved, the above test pressure shall apply to the lowest pressure-rated casing used. Test pressures shall be applied for a period of thirty minutes. If a drop of more than ten percent of the test pressure should occur, the casing or cement job shall be considered defective and corrective measures shall be taken before commencing any further operations on the well.

Casing Pressure Test:

1. Project name ______________________________

2. Drilling company ______________________________

3. Well name and number ______________________________

4. Location ______________________________

5. Person(s) taking test ______________________________

6. Date of test ______________________________

7. Time of test ______________________________

8. Depth of hole ______________________________

9. Size of last casing string ______________________________

10. Depth to top of casing (Casing Lap) ______________________________

11. Depth to bottom of casing (Casing Shoe) ______________________________

12.(a) Pressure at which casing tested (to Master Valve) ______________________________

(b) Drop In Pressure to (after 30 minutes) ______________________________

13.(a) Pressure at which Blind Rams tested ______________________________

(b) Drop In Pressure to (after 30 minutes) ______________________________

14.(a) Pressure at which Pipe Rams tested ______________________________

(b) Drop in pressure to (after 30 minutes) ______________________________

Other Information: (use additional sheet, if necessary).

# WELL STATUS REPORT
# EXISTING PRODUCTION WELLS
# PUNA GEOTHERMAL VENTURE SITE

The following is a summary of the current status of the existing production well located on the Puna Geothermal Venture designated project area. The well locations are shown in Figure 1.

1. KS-1 (Figure 2)

Production well KS-1 was plugged with cement by Thermal Power on April 28, 1983. The plug was set from a depth of 1750 feet to a depth of 2153 feet. The well is completed with a single 2000# master gate valve which is maintained in the closed position and is locked. Wellhead pressure is stable at 6 psi. The gas observed when the pressure is bled through the side valve contains no H2S.

2. KS-2 (Figure 3)

Production well KS-2 was plugged with cement by Thermal Power on March 29, 1983. The plug was set from a depth of 2984 feet to a depth of 3175 feet. The well is completed with a single 2000# master gate valve which is maintained in the closed position and is locked. There is no pressure at the wellhead.

3. KS-1A (Figure 4)

Production well KS-1A was plugged with cement by Puna Geothermal Venture on June 1, 1989. The plug was set from a depth of 3542 feet to a depth of 3692 feet. The well is completed with two 3000# master gate valves which are maintained in the closed position and are locked. There is no pressure at the wellhead.

4. KS-3 (Figure 5, 6)

Production well KS-3 was completed by PGV on January 25, 1991. The well was drilled to a measured depth 7406 feet. A 511' fish was left in the bottom of the hole. The well is currently shut in with water in the casing to the wellhead. The wellhead pressure is 5 psi. No gas cap has been observed to date.

5. Injection Well KS-7 (Figure 7, 8)

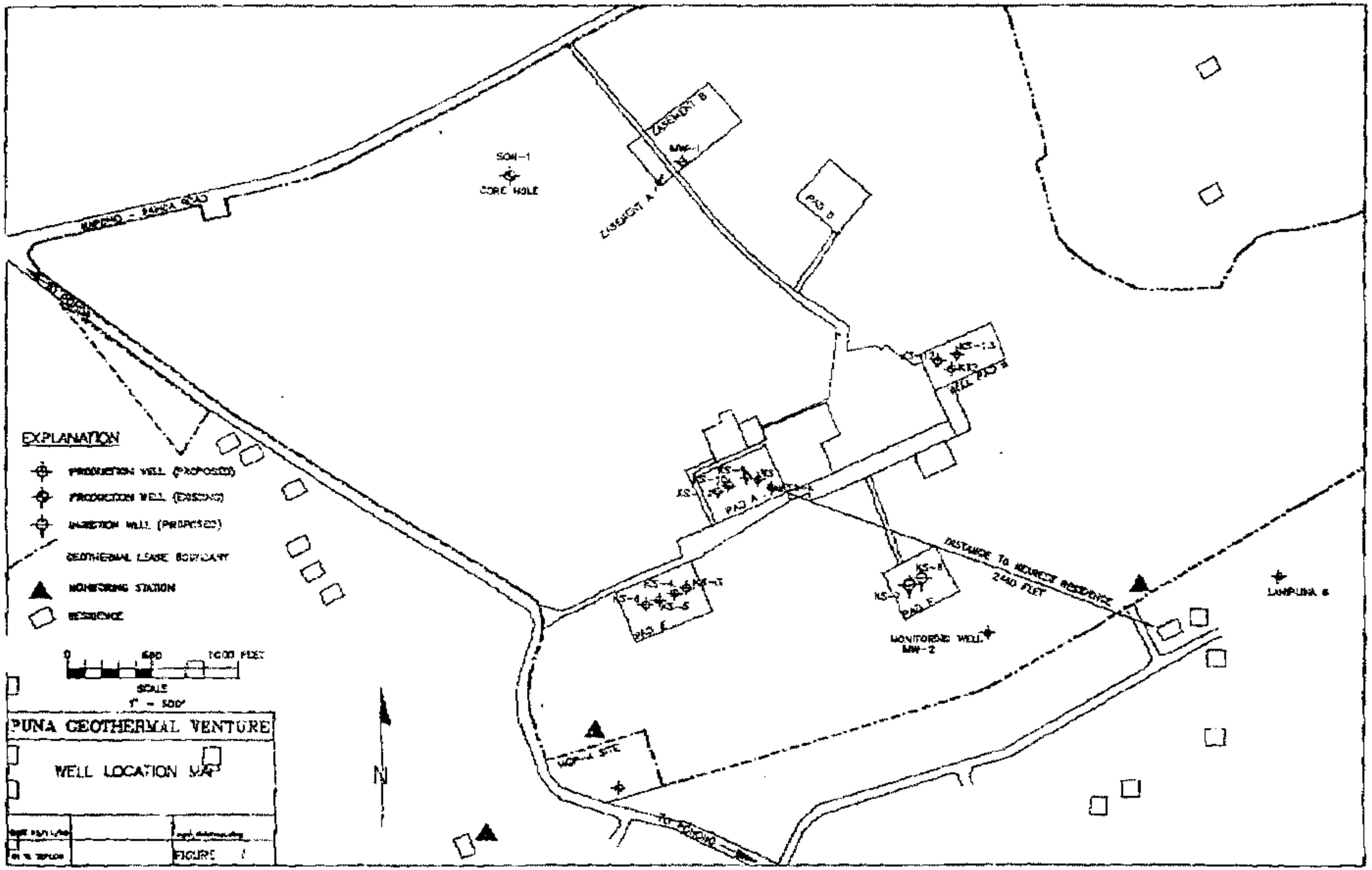
KS-7 was spudded on January 30, 1991. 13-3/8" K-55 54# BT&C casing was set and cemented to 1020 feet. During the drilling of the 12-1/4" hole, an unanticipated high temperature, high pressure zone was encountered in the 1500 foot to 1678 foot interval. The hole bridged at a depth of 1277 feet. A cement plug was placed from 1277 feet to a depth of 740 feet. Drilling operations are currently suspended for this well with the rig on the hole and the BOP in place. Pressure and temperature in the casing and adjacent monitoring well MW-2 are being monitored daily. No H2S gas has been detected from either well.

6. Monitoring\Water Supply Well MW-1 (Figure 9)

MW-1 was completed by PGV on December 30, 1990 to a depth of 731 feet. A 75 hp submersible pump was installed and the well was put in service to supply water for production drilling operations and fire protection. The well is also sampled periodically as part of the Hydrologic Monitoring Program.

7. Monitoring Well MW-2 (Figure 10)

MW-2 was completed on January 21, 1991 to a depth of 646 feet. The well completed with 4" pipe which is perforated in the bottom 50 feet. The well is sampled periodically as part of the Hydrologic Monitoring Program.


EXPLANATION
PRODUCTION WELL (PROPOSED)
PRODUCTION WELL (EXISTING)
INJECTION WELL (PROPOSED)
GEOTHERMAL LEASE BOUNDARY
MONITORING STATION
RESIDENCE
0
500
1000 FEET
SCALE
1" = 500'
PUNA GEOTHERMAL VENTURE
WELL LOCATION MAP
FIGURE 1
N
SOH-1
CORE HOLE
EASEMENT B
MW-1
EASEMENT A
PAD B
PAD A
PAD E
PAD F
MONITORING WELL
MW-2
DISTANCE TO NEAREST RESIDENCE
2240 FEET
LANIPUNA 6
TO POHOIKI

# PGV WELL KS-1A

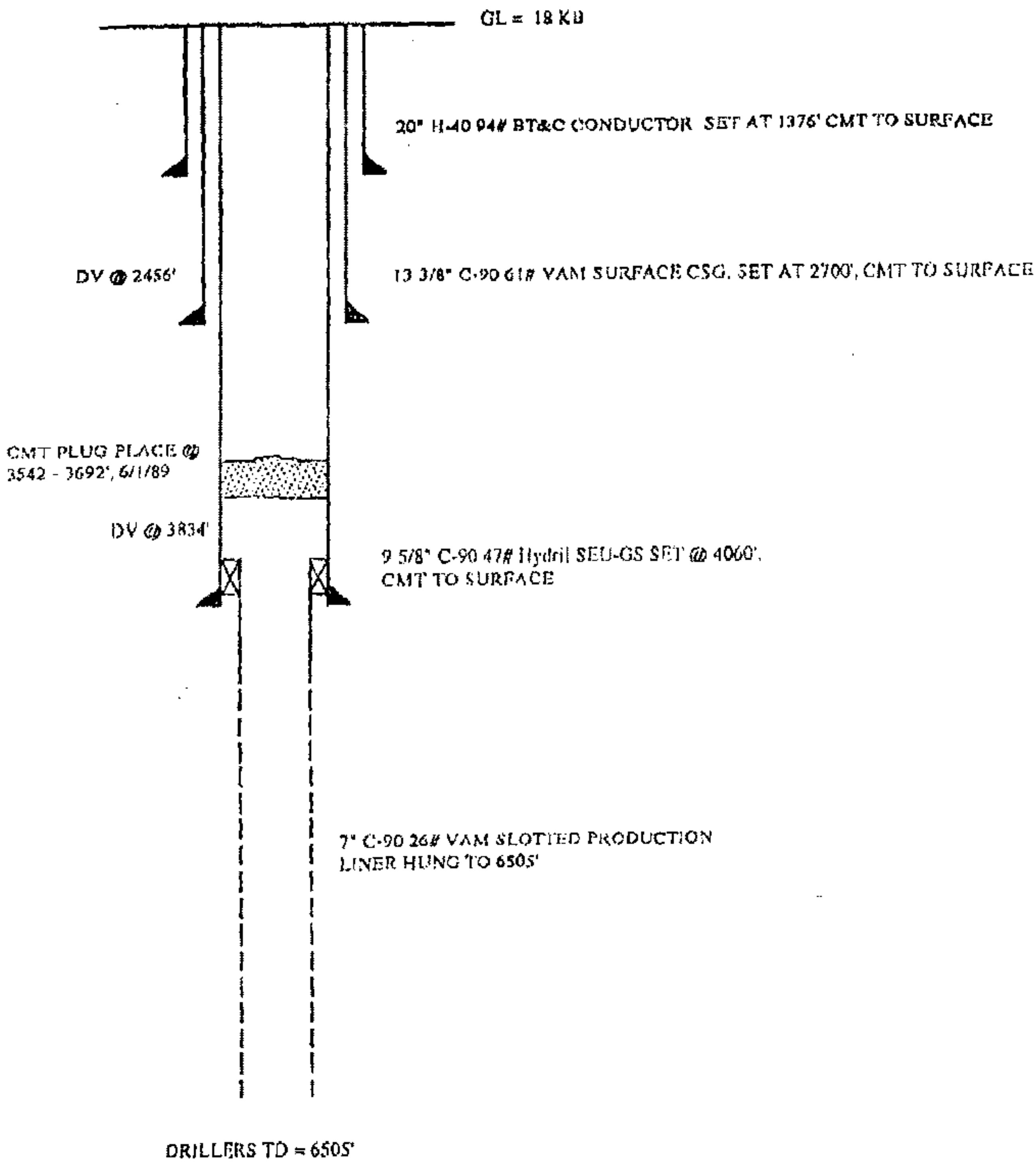



Figure 4

**ORMAT**®

October 15, 1990

Mr. William Paty
Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, HI 96809

Subject: Puna Geothermal Venture
<u>Quarterly Well Monitoring Report</u>

Dear Mr. Paty,

As requested by the Department of Land and Natural Resources (DLNR), Puna Geothermal Venture (PGV) respectfully submits the following quarterly well reports for Kapoho State 1, Kapoho State 1A and Kapoho State 2.

The results of the attached well reports indicate that the wellhead pressures for each of the PGV wells remained static during the previous three months. No $H_2S$ was detected at any of the wellheads. All master valves and side valves for the three wells were serviced, function tested, and found to be in good operating condition. If there are any questions, or if more information is required, please feel free to contact the PGV office in Hilo at 961-2786.

Sincerely,

Bill Teplow

Bill Teplow
Field Manager

Attachment

cc: B. Clark w/encl.
Z. Reiss w/encl.
J. Sternfeld w/encl.

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 • Hilo, Hawaii 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

QUARTERLY WELL REPORT

KAPOHO STATE 1-A

Months Covered Under This Report: July, 1990 - September, 1990

| Date | Pressure (psi) | Comments |
|---|---|---|
| July 02, 1990 | 0 | Water level 210' |
| July 04, 1990 | 0 | Water level 280' |
| July 08, 1990 | 0 | Water level 310' |
| July 11, 1990 | 0 | Water level 310' |
| July 15, 1990 | 0 | Under vacuum |
| July 18, 1990 | 0 | Under vacuum |
| July 22, 1990 | 0 | Under vacuum |
| July 25, 1990 | 0 | Under vacuum; Pumped cellar |
| July 29, 1990 | 0 | Under vacuum |
| August 03, 1990 | 0 | Under vacuum |
| August 06, 1990 | 0 | Under vacuum |
| August 10, 1990 | 0 | Water level 385' |
| August 13, 1990 | 0 | Under vacuum |
| August 17, 1990 | 0 | Under vacuum |
| August 20, 1990 | 0 | Under vacuum |
| August 24, 1990 | 0 | Water level 395' |
| August 27, 1990 | 0 | Under vacuum |
| August 31, 1990 | 0 | Under vacuum |
| September 03, 1990 | 0 | Under vacuum |
| September 07, 1990 | 0 | Under vacuum |
| September 10, 1990 | 0 | Under vacuum; Pumped cellar |
| September 14, 1990 | 0 | Under vacuum |
| September 17, 1990 | 0 | Under vacuum |
| September 21, 1990 | 0 | Under vacuum |
| September 24, 1990 | 0 | Under vacuum |
| September 28, 1990 | 0 | Under vacuum |

RECEIVED

90 SEP 18 A8:39

DIV. OF WATER &
LAND DEVELOPMENT

ORMAT®

September 14, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Request for Modification of Geothermal Production Well KS-1A, Puna Geothermal Venture.

Dear Mr. Tagomori:

Puna Geothermal Venture (PGV) is proposing to modify the casing and wellhead of geothermal production well KS-1A. PGV is hereby seeking approval from your office for this Request for Modification. The purpose of the modification is to strengthen the production casing string, eliminate possible casing leaks, and repair damage to the 9-5/8" casing within the the expansion spool. This will assure good casing integrity when KS-1A is placed in service as a production well.

The proposed work will consist of running a string of 7" cemented production liner from the surface to a depth of 3540'. Also, the 13-3/8" casing head will be replaced with a 9-5/8" casing head and 7" explansion spool. This proposed work is described in detail in the attached workover program.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 HILO, HAWAII 96721-1337 • Telephone (808) 961-2786 • Facsimile (808) 935-5562

KS-1A REWORK AND WELLHEAD REPAIR

1. Move rig over well.

2. Remove top 10" valve. Install API 3000# double gate BOP and annular preventer on top of 10" master valve.

3. Run drill pipe to top of cement plug (3500') and circulate well with cold water 4 hrs or until return temperature is stable. Start pumping at 1 barrel per minute to avoid thermal shocking well casing.

4. Mix 20 cubic feet (50 Linear feet) geothermal cement (type II with 40% silica flour) and spot on top of existing plug. W.O.C. 6 hours.

5. Remove BOP, wellhead valve and 13 3/8" x 9 5/8" expansion spool. Remove 13 3/8" x 20" expansion spool. Cut off 20" casing at floor of cellar. If no cement in 30" x 20" annulus run 1" tubing to top of cement and blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

6. Cut-off 13 3/8" casing 10' below surface. Run 1" pipe in 20" x 13 3/8" annulus to top of cement. Blow annulus dry with air. Mix appropriate volume of geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

7. Cut-off 9 5/8" casing 8' below surface and dress for welding. Center 9 5/8" casing inside 13 3/8" casing. Run 1" pipe in 13 3/8" x 9 5/8" annulus to top of cement. Blow annulus dry with air. Mix geothermal cement and cement annulus through 1" pipe. W.O.C. 8 hrs.

8. Weld API 3000# casing head on 9 5/8" casing. Assemble double gate BOP and annular preventer on casing head.

9. Pressure test casing to 500 psi and hold for 10 minutes.

10. It pressure bleeds-off, conduct injection test and spinner survey to locate source of leak.

11. Run drill pipe to leak and circulate water 4 hours. Mix 40 cubic feet geothermal cement and place opposite leak through drill pipe, pull up 2 stands and squeeze. W.O.C. 6 hrs.

12. Run in with 8 1/2" bit and drill cement.

13. Repeat pressure test. Repeat squeeze if test fails.

14. Run drill pipe to 3400 feet and blow well dry with air.

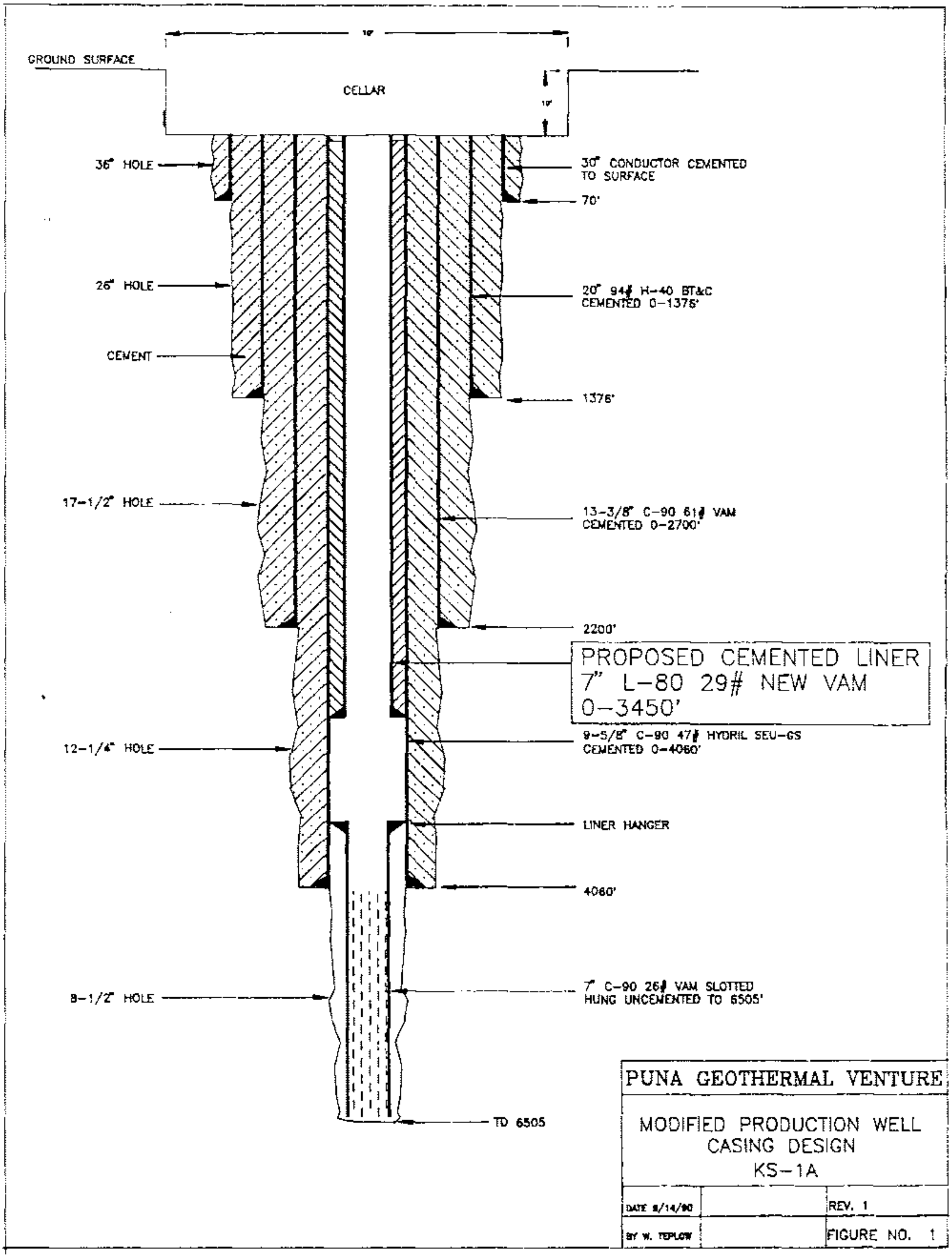
15. Run 3450 feet 7", L80, 29#, New Vam casing with centralizers on bottom three joints and 5th joint from surface. Cement to surface with 500 cubic feet geothermal cement (type II + 40% silica flour + 0.65% CFR-3). After plug is bumped unbolt and raise BOP at casing head flange. Set 7" casing alignment bowl. W.O.C. 12 hours.

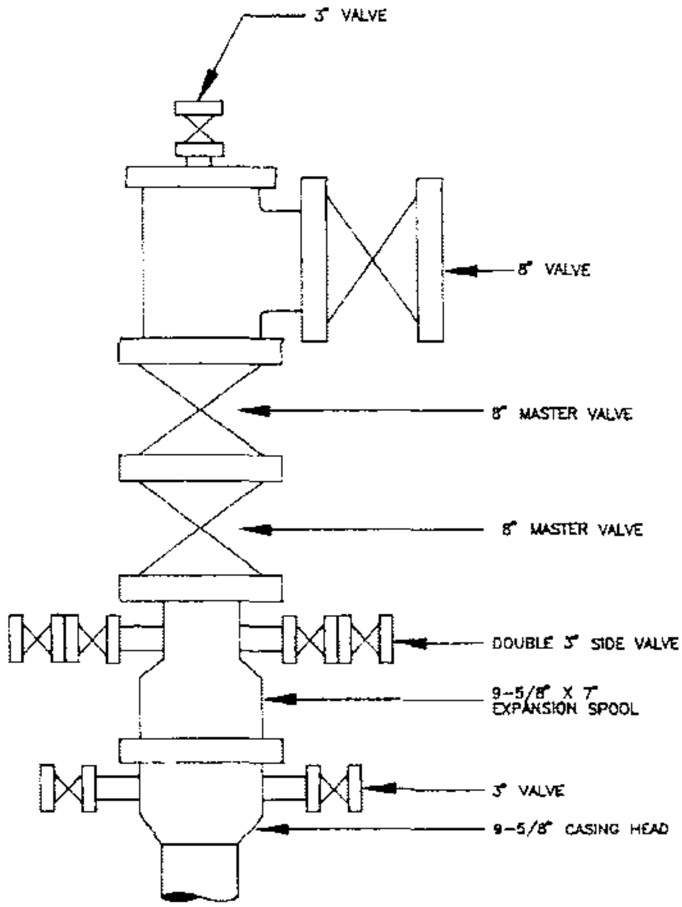
16. Install API 3000# 9 5/8" x 7" expansion spool and pack-off. Install 8" ANSI 900 wellhead valve. Reassemble double gate BOP and annular preventer.

17. Run 6" bit and drill out cement plug with water. Run bit to top of 7" liner.

18. POOH laying down drill pipe. Remove BOP and install second 8" ANSI 900 wellhead valve.

19. Allow well to warm approximately 15 days. Install flowline to storage pit and flow well approximately 30 minutes to clean.


10'
GROUND SURFACE
CELLAR
10'
36" HOLE
30" CONDUCTOR CEMENTED TO SURFACE
70'
26" HOLE
20" 94# H-40 BT&C CEMENTED 0-1376'
CEMENT
1376'
17-1/2" HOLE
13-3/8" C-90 61# VAM CEMENTED 0-2700'
2200'
PROPOSED CEMENTED LINER 7" L-80 29# NEW VAM 0-3450'
12-1/4" HOLE
9-5/8" C-90 47# HYDRIL SEU-GS CEMENTED 0-4060'
LINER HANGER
4060'
8-1/2" HOLE
7" C-90 26# VAM SLOTTED HUNG UNCEMENTED TO 6505'
TD 6505
PUNA GEOTHERMAL VENTURE
MODIFIED PRODUCTION WELL CASING DESIGN
KS-1A
DATE 8/14/90
REV. 1
BY W. TEPLOW
FIGURE NO. 1




| | | |
|---|---|---|
| PUNA GEOTHERMAL VENTURE | | |
| MODIFIED WELLHEAD CONFIGURATION PRODUCTION WELL KS-1A | | |
| DATE 8/14/90 | | REV. 1 |
| BY W. TEPLOW | | FIGURE NO. 2 |

September 9, 1990

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Casing integrity test conducted on KS-1A, Puna Geothermal Project site. Casing status, KS-1.

Dear Mr. Tagomori:

As per your letter of August 6, 1990 to Maurice Richard, I would like to respond to your inquiries regarding the casing integrity test performed on well KS-1A.

The PGV staff conducted the casing integrity test on KS-1A commencing on June 26, 1990. The test consisted of filling the 9-5/9" casing with water to ground level and then observing the water level decline over time. Results of the test are shown in the attached Table 1 and Figure 1.

The following observations were made during the test:

1. The water level prior to filling the well was at a depth of 550 feet below ground level.

2. After filling, the water level dropped in the first 24 hours at an average rate of 2.5 feet/hour. This is equivalent to a fluid loss rate of 0.128 gpm.

3. The initial pressure increase above normal water level that was created by filling the well with cold water was calculated to be 236 psi.

4. During the latter part of the test from August 10-24, 1990, the fluid loss rate declined to an average of 0.015 gpm.

5. After 710 hours, the water level appeared to be approaching stabilization at a depth of 390 feet.

From the above observations we conclude the following:

1. The casing leak is through a relatively small opening, probably less than 0.02" diameter.

2. The cement plug placed at 3542'-3692' on June 1, 1989 by

PGV is effective in not allowing any fluid or gas to migrate up the wellbore from the geothermal reservoir. Therefore, no contamination of ground water by geothermal fluid can now be occurring from the suspected leak.

Remedial action to cure the observed casing leak is now being planned by PGV. The rework program for KS-1A will consist of running and cementing a 7" liner from the surface to a depth of 3640'. This additional cemented string will eliminate any possibility of leakage by geothermal fluid into the shallow ground water aquifers when KS-1A is put into production. The rework program will be submitted to DLNR by September 20, 1990 as a Request for Well Modification.

Also in your August 6 letter, you requested an as-build drawing of KS-1 showing the location and thickness of cement plugs. That drawing is attached herein as Figure 2.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

Bill Teplow

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

Table 1

Water Level Measurements
KS-1A
June 26, 1990 - August 24, 1990

| Date | Hours | Water Level (ft) Below Surface |
|---|---|---|
| 26-Jun-90 | 0 | 0 |
| 27-Jun-90 | 22 | 55 |
| 28-Jun-90 | 46 | 75 |
| 29-Jun-90 | 70 | 130 |
| 02-Jul-90 | 142 | 210 |
| 04-Jul-90 | 190 | 280 |
| 08-Jul-90 | 310 | 310 |
| 25-Jul-90 | 718 | 380 |
| 10-Aug-90 | 1102 | 385 |
| 24-Aug-90 | 1438 | 395 |

KS−1A WATER LEVEL BEHAVIOR
AFTER FILLING 9 5/8 IN. CASING
TO GROUND LEVEL WITH WATER.
START OF TEST: JUNE 26, 1990.
WATER LEVEL PRIOR TO FILLING: −550 FT.

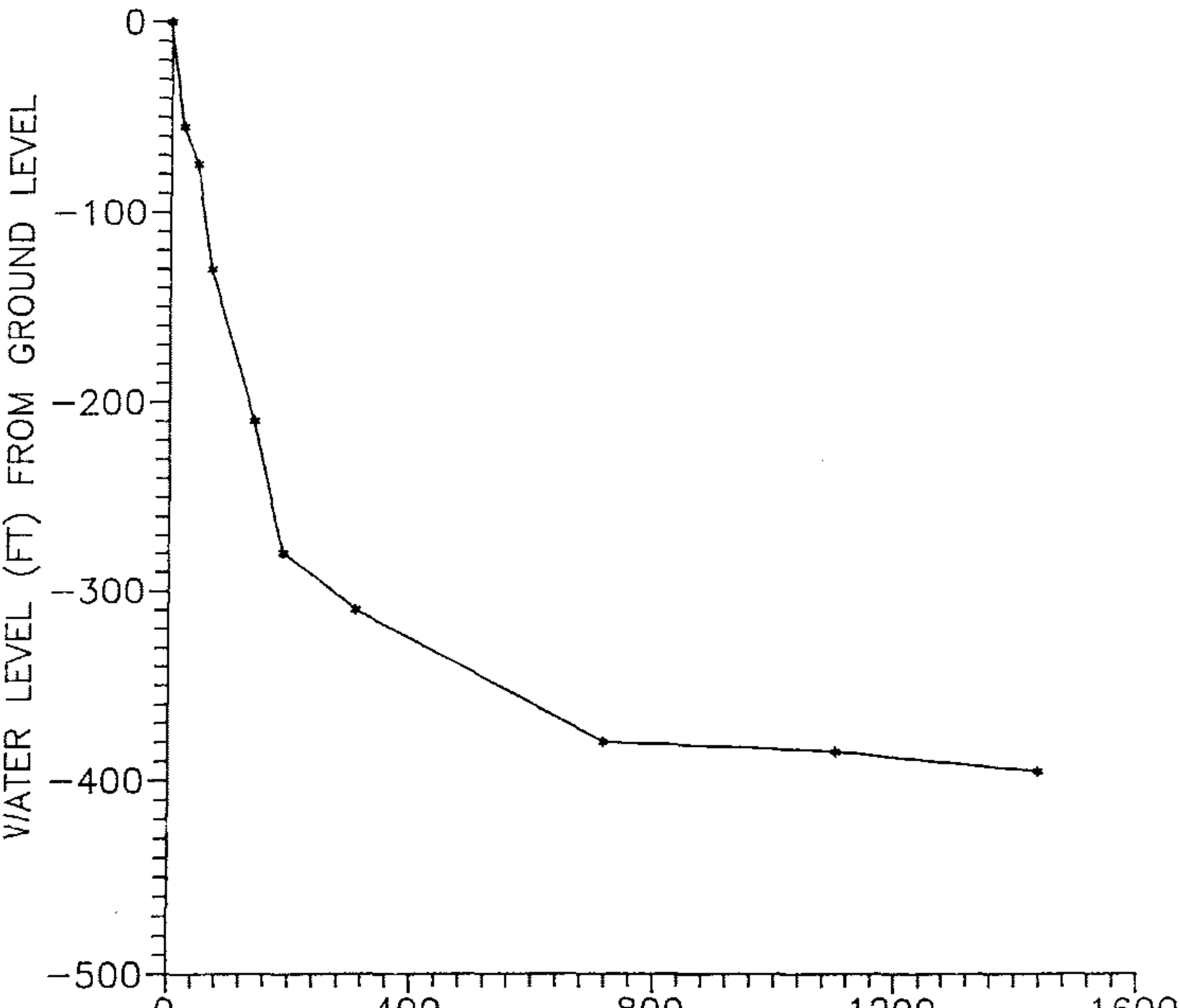
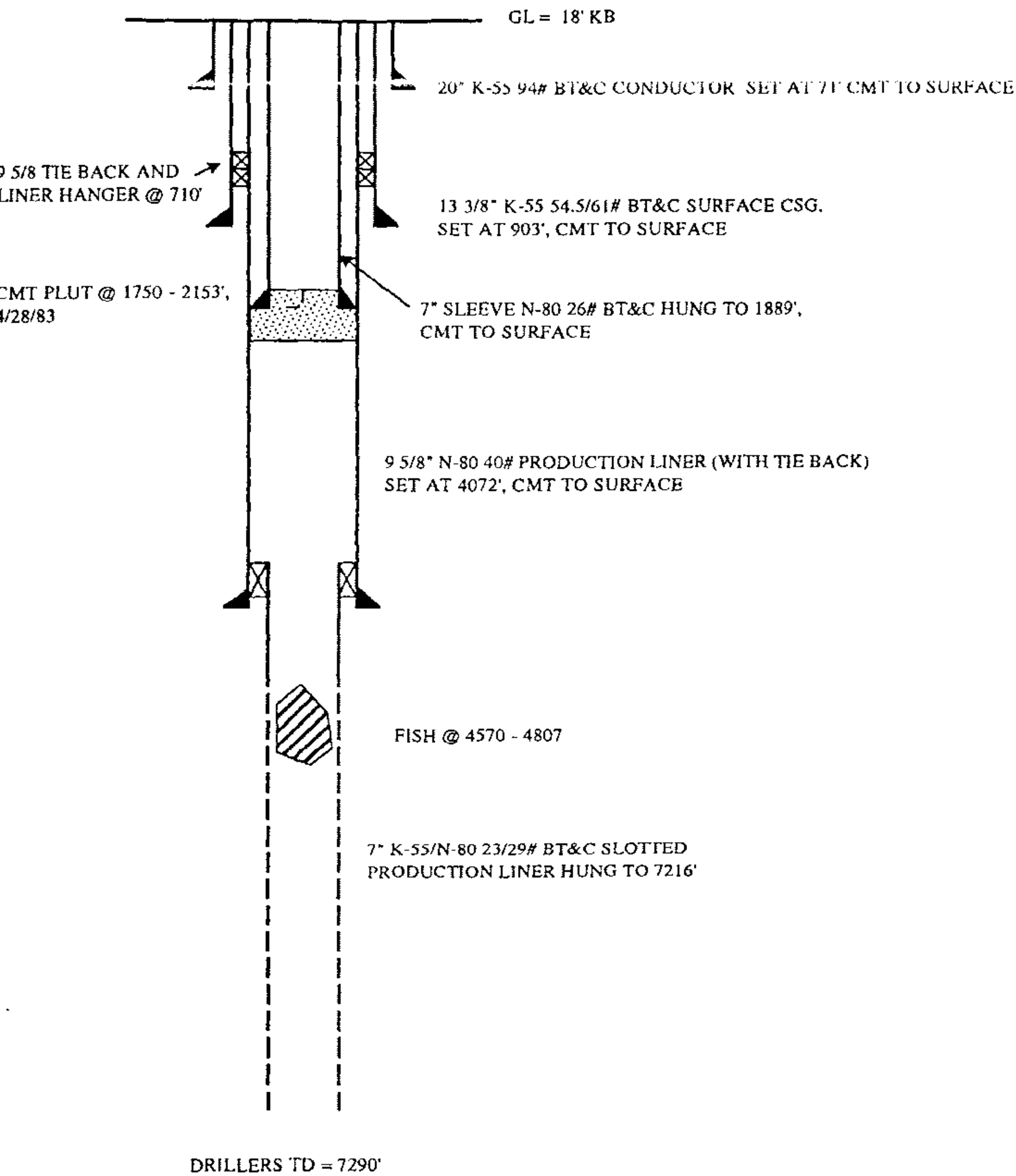


FIGURE 2

# PGV WELL KS-1



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90 SEP 14 A8:57

September 9, 1990

DIV. OF WATER & LAND DEVELOPMENT

Mr. Manabu Tagomori, Deputy Director
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Re: Casing integrity test conducted on KS-1A, Puna Geothermal Project site. Casing status, KS-1.

Dear Mr. Tagomori:

As per your letter of August 6, 1990 to Maurice Richard, I would like to respond to your inquiries regarding the casing integrity test performed on well KS-1A.

The PGV staff conducted the casing integrity test on KS-1A commencing on June 26, 1990. The test consisted of filling the 9-5/9" casing with water to ground level and then observing the water level decline over time. Results of the test are shown in the attached Table 1 and Figure 1.

The following observations were made during the test:

1. The water level prior to filling the well was at a depth of 550 feet below ground level.

2. After filling, the water level dropped in the first 24 hours at an average rate of 2.5 feet/hour. This is equivalent to a fluid loss rate of 0.128 gpm.

3. The initial pressure increase above normal water level that was created by filling the well with cold water was calculated to be 236 psi.

4. During the latter part of the test from August 10-24, 1990, the fluid loss rate declined to an average of 0.015 gpm.

5. After 710 hours, the water level appeared to be approaching stabilization at a depth of 390 feet.

From the above observations we conclude the following:

1. The casing leak is through a relatively small opening, probably less than 0.02" diameter.

2. The cement plug placed at 3542'-3692' on June 1, 1989 by

PUNA GEOTHERMAL VENTURE CONSTRUCTION
P.O. Box 1337 Hilo, Hawaii 96721-1337
~~99 Aupuni Street #114~~ • ~~Hilo, Hawaii 96720~~ • Telephone (808) 961-2786 • Facsimile (808) 935-5562

PGV is effective in not allowing any fluid or gas to migrate up the wellbore from the geothermal reservoir. Therefore, no contamination of ground water by geothermal fluid can now be occurring from the suspected leak.

Remedial action to cure the observed casing leak is now being planned by PGV. The rework program for KS-1A will consist of running and cementing a 7" liner from the surface to a depth of 3540'. This additional cemented string will eliminate any possibility of leakage by geothermal fluid into the shallow ground water aquifers when KS-1A is put into production. The rework program will be submitted to DLNR by September 20, 1990 as a Request for Well Modification.

Also in your August 6 letter, you requested an as-build drawing of KS-1 showing the location and thickness of cement plugs. That drawing is attached herein as Figure 2.

If you have any questions regarding this material, please give me a call.

Sincerely,
PUNA GEOTHERMAL VENTURE

Bill Teplow

William J. Teplow
Field Manager

cc: Norman Clark
Maurice Richard
Terry Crowson

Table 1

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KS-1A
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| 02-Jul-90 | 142 | 210 |
| 04-Jul-90 | 190 | 280 |
| 08-Jul-90 | 310 | 310 |
| 25-Jul-90 | 718 | 380 |
| 10-Aug-90 | 1102 | 385 |
| 24-Aug-90 | 1438 | 395 |

FIGURE 1

KS-1A WATER LEVEL BEHAVIOR
AFTER FILLING 9 5/8 IN. CASING
TO GROUND LEVEL WITH WATER.
START OF TEST: JUNE 26, 1990.
WATER LEVEL PRIOR TO FILLING: -550 FT.

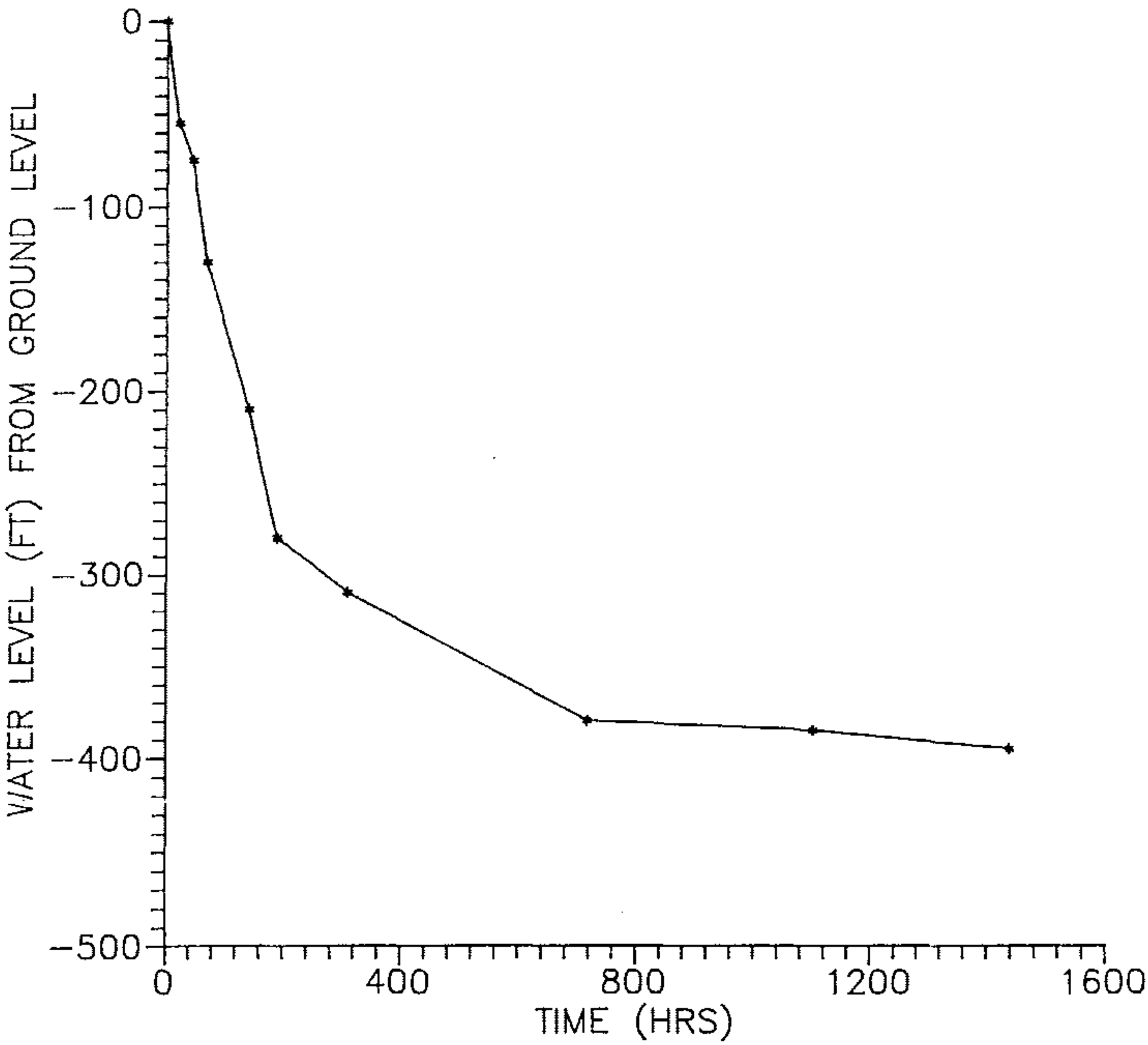
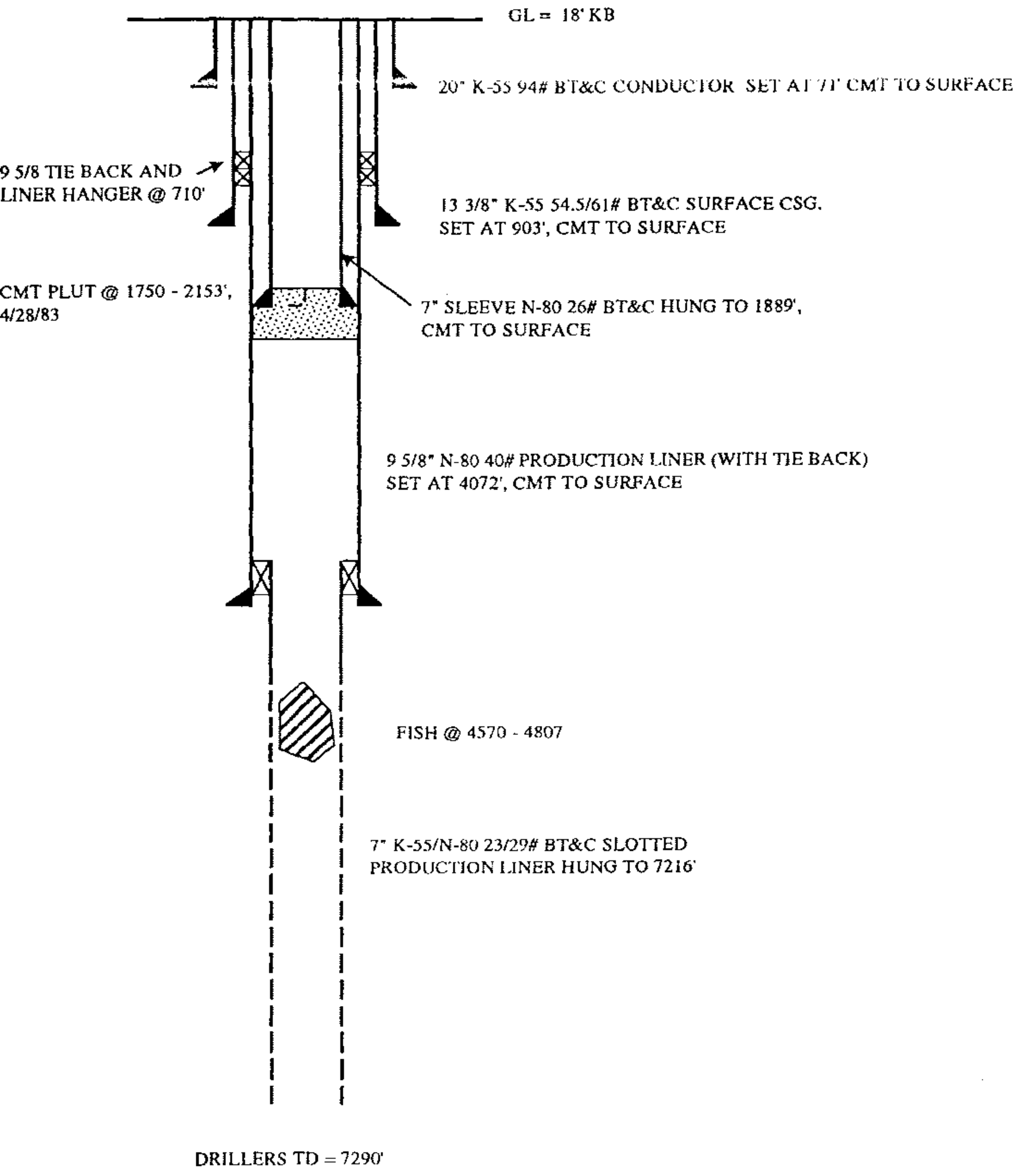


FIGURE 2

# PGV WELL KS-1



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July 26, 1990
Reference No. 90263.011

Mr. William Paty
Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Subject: Puna Geothermal Venture
Kapoho State-1A Well Quarterly Monitoring Report

Dear Mr. Paty:

Puna Geothermal Venture (PGV) respectfully submits the attached quarterly well monitoring report for the Kapoho State 1-A (KS 1-A) well located on the PGV project property.

If there are any questions, please feel free to contact the PGV office in Hilo at 961-2184.

Sincerely,

Maurice A. Richard
Regional Development Manager

Attachment

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
☐ 610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125

KAPOHO STATE 1-A WELL
QUARTERLY REPORT
April - June 1990

| Date | Pressure (psi) | Comments |
|---|---|---|
| April 2, 1990 | 0 | |
| April 6, 1990 | 0 | |
| April 9, 1990 | 0 | |
| April 14, 1990 | 0 | |
| April 17, 1990 | 0 | |
| April 20, 1990 | 0 | |
| April 24, 1990 | 0 | |
| April 27, 1990 | 0 | |
| April 30, 1990 | 0 | |
| May 3, 1990 | 0 | |
| May 7, 1990 | 0 | |
| May 12, 1990 | 0 | |
| May 14, 1990 | 0 | |
| May 18, 1990 | 0 | |
| May 21, 1990 | 0 | |
| May 26, 1990 | 0 | |
| May 30, 1990 | 0 | |
| June 4, 1990* | | Slight vaccuum |
| June 8, 1990 | | Slight vaccuum |
| June 11, 1990 | | Slight vaccuum |
| June 15, 1990 | | Slight vaccuum |
| June 18, 1990 | | Slight vaccuum |
| June 22, 1990 | | Slight vaccuum |
| June 26, 1990 | | Filled well w/17.5 barrel of water; water at surface |
| June 27, 1990 | | Vaccuum; fluid dropped 55 feet in 22 hours |
| June 28, 1990 | | Vaccuum; fluid dropped 75 feet in 46 hours |
| June 29, 1990 | | Vaccuum; water dropped 130 feet in 70 hours |

* Well monitoring duties switched to Terry Crowson, PGV Drilling Superintendent.

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DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII

April 2, 1990
Reference No. 90116.011

Mr. William Paty
Chairperson
Department of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Subject: Puna Geothermal Venture
Kapoho State-1A Well Quarterly Monitoring Report

Dear Mr. Paty:

As requested by the Department of Land and Natural Resources (DLNR) in a letter dated February 2, 1990, Puna Geothermal Venture (PGV) respectfully submits the following quarterly well report for the Kapoho State-1A (KS 1-A) well located on PGV project property.

The results of the attached report indicate the wellhead pressure has not exceeded 0 psi during the previous three months. If there are any questions, or if more information is required, please feel free to contact the PGV office in Hilo at 961-2184.

Sincerely,

~~Maurice A.~~ Richard
Regional Development Manager

Attachment

MAR/ci

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
☐ 610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125

KAPOHO STATE 1-A WELL QUARTERLY REPORT

Months Covered Under This Report: January 1990 - march 1990

| Date | Time | Pressure (psi) | Comments |
|---|---|---|---|
| January 2, 1990 | 0800 | 0 | |
| January 8, 1190 | 0800 | 0 | |
| January 13, 1990 | 0730 | 0 | |
| January 16, 1990 | 1300 | 0 | |
| January 20, 1990 | 0830 | 0 | |
| January 22, 1990 | 0800 | 0 | |
| January 26, 1990 | 0930 | 0 | |
| January 29, 1990 | 0830 | 0 | DLNR well inspection |
| February 1, 1990 | 0900 | 0 | |
| February 3, 1990 | 0800 | 0 | |
| February 6, 1990 | 0800 | 0 | |
| February 9, 1990 | 0800 | 0 | |
| February 12, 1990 | 1030 | 0 | |
| February 13, 1990 | 1330 | 0 | |
| February 16, 1990 | 0800 | 0 | |
| February 20, 1990 | 0830 | 0 | |
| February 21, 1990 | 0830 | 0 | Padlocks vandalized |
| Febraury 25, 1990 | 1300 | 0 | |
| February 27, 1990 | 0730 | 0 | Secure wellhead master valves |
| March 3, 1990 | 0900 | 0 | |
| March 5, 1990 | 0800 | 9 | |
| march 9, 1990 | 0900 | 0 | |
| March 12, 1990 | 0800 | 0 | |
| march 16, 1990 | 0730 | 0 | |
| March 19, 1990 | 0700 | 0 | |
| March 20, 1990 | 0730 | 0 | Change wellhead pressure guages |
| March 26, 1990 | 0800 | 0 | |
| March 28, 1990 | 0900 | 0 | |
| march 29, 1990 | 0800 | 0 | DLNR well inspection |

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DEPT. OF LAND & NATURAL RESOURCES STATE OF HAWAII



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February [illegible] 1990
Reference 90028-011

Mr. William Paty
Chairperson
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. Paty:

In response to Mr. Dean Nakano's telephone request on January 22, 1990, please find enclosed the temperature and pressure survey runs for KS1-A for May 31, 1989, June 1, 1989, and June 2, 1989. This information was inadvertantly omitted from our letter dated January 3, 1990 (our reference 90002). Puna Geothermal Venture considers this data proprietary and requests that the Department of Land and Natural Resources not disclose any portion of it to a third party without prior written approval from Puna Geothermal Venture.

We hope the information provided is satisfactory and its delay has not cause any incovenience. If there are any questions, or if we can be of further assistance, please feel free to contact this office.

Sincerely,

Christine Iha

Christine Iha
Environmental Coordinator

Enclosure


PUNA GEOTHERMAL VENTURE

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Temperature and Pressure Surveys Run in KS-1A

in Conjunction with Setting Cement Plug June 1989

5/31/89

| Depth (ft) | Temp (°F) | Pressure (psig) |
|---|---|---|
| 1500 | 93 | 306 |
| 2000 | 123 | 519 |
| 2500 | 160 | 730 |
| 3000 | 203 | 934 |
| 3500 | 228 | 1136 |
| 3800 | 268 | 1282 |

6/1/89

| Depth (ft) | Temp (°F) | Pressure (psig) |
|---|---|---|
| 1500 | 96 | 285 |
| 2000 | 123 | 496 |
| 2500 | 158 | 710 |
| 3000 | 201 | 917 |
| 3500 | 228 | 1118 |
| 3880 | 264 | 1263 |
| **Injection off** | | |
| 3 min. | 272 | 1256 |
| 6 | 280 | 1252 |
| 9 | 287 | 1246 |
| 12 | 297 | 1244 |
| 15 | 305 | 1244 |

6/2/89

| Depth (ft) | Temp (°F) | Pressure (psig) |
|---|---|---|
| 1500 | 118 | 420 |
| 2000 | 238 | 624 |
| 2500 | 273 | 824 |
| 3000 | 350 | 1010 |
| 3500 | 403 | 1195 |
| 3541 | 407 | 1208 |

Water level @ 471 feet

1479

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September 21, 1989
Reference No. 89295

Mr. William W. Paty
Chairperson
Board of Land and Natural Resources
Kalanimoku Building, #130
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Well Completion Report

Reference: Geothermal Well: Kapoho State #1-A
Geothermal Resources Mining Lease R-2
Location TMK 1-4-01:02 Kapoho, Puna District,
Hawaii County Leased to Kapoho Land Partnership

Dear Mr. Chairman:

Pursuant to the Geothermal Well Modification Permit for Kapoho State 1-A, issued on June 6, 1989, attached please find the well completion report and an as-built drawing indicating the location of the temporary cement plug in the well casing.

We hope all is in order. If there are any additional questions, or if we may be of further assistance, please feel free to contact our Hilo office at 961-2184.

Sincerely,

Maurice A. Richard
Regional Development Manager

Attachement

MAR:ci

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
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Report On Temporarily Suspending Well KS-1A

With A Cement Plug

June 1, 1989

## 1. Summary

A cement plug was successfully placed between 3542 feet and 3692 feet in KS-1A on June 1, 1989. The current status of the well is shown in the attached figure. The cement plug has isolated the surface from the geothermal reservoir and has eliminated the need to conduct $H_2S$ gas burns.

A casing pressure test was not carried out at the time the plug was set in order to give it sufficient time to develop full strength. Also, a pressure test runs the risk of dislodging the plug in which case a rig and additional pumping and cementing equipment would be needed to remedy the situation. This equipment was not available at the time and therefore it was believed prudent not to conduct the pressure test.

In lieu of the pressure test the well condition is being monitored on a regular basis for evidence of a casing leak.

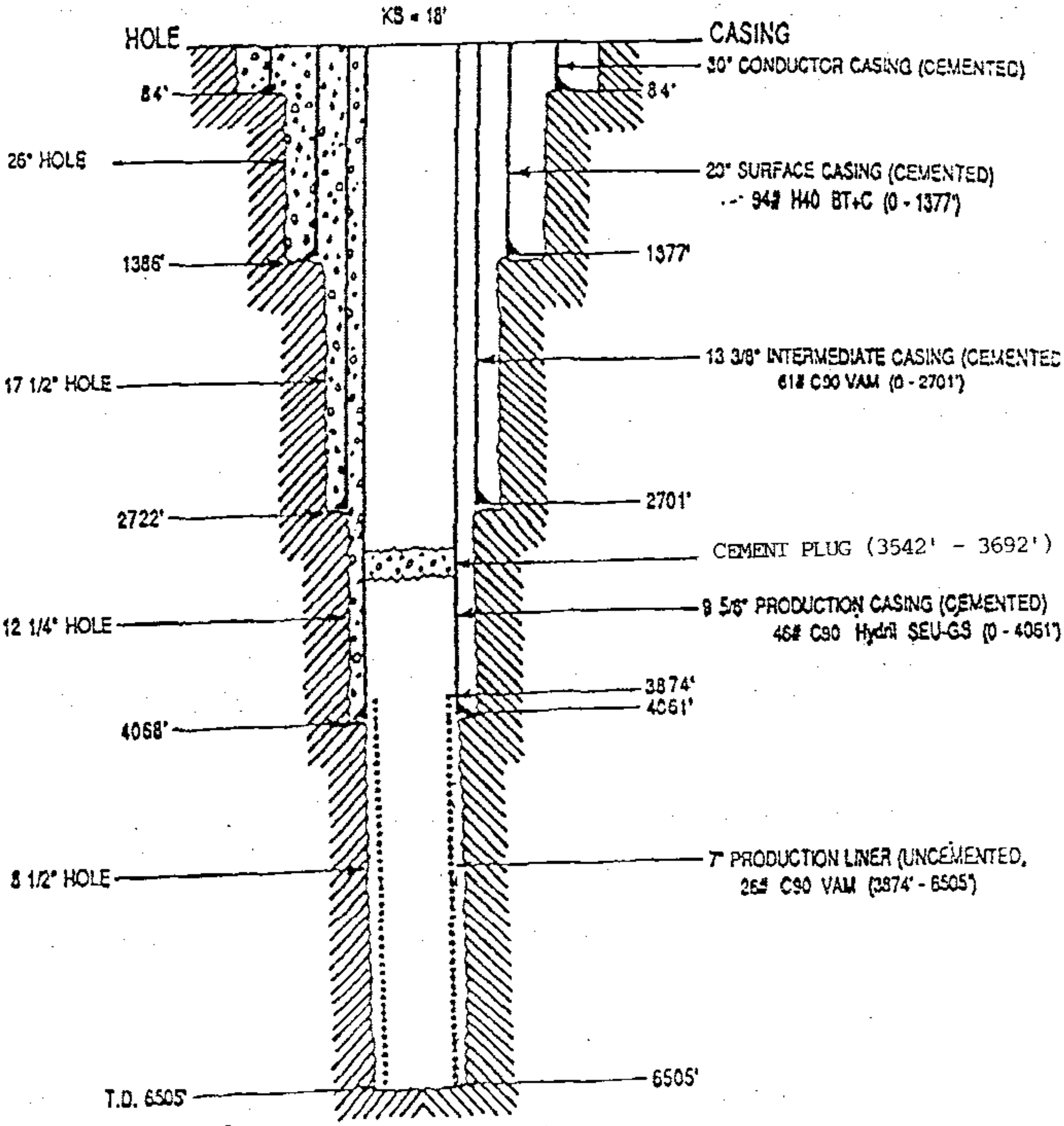
A leak through the cement plug would allow gas to percolate from the reservoir up the well and would be evidenced as a build-up in wellhead pressure. No build-up has been observed during the 3 months since the well was plugged.

Alternatively, a leak in the casing above the cement plug would cause the water level inside the well to equilibrate with the ground water level which is about 600 feet below the surface in this location. The water level in the well is currently stable at about 220 feet below the surface which indicates the casing above the plug is sound.

## 2. Chronology of Operation

| | | |
|---|---|---|
| 5/30/89 | 0700 | Commence gas burn from initial pressure of 380 psig. |
| | 1040 | Fluid at surface, WHP = 285 psig.<br>Start water kill @ 16 gpm. |
| | 1600 | Continue kill. WHP = 110 psig, Q = 25 gpm. |
| | 2200 | Well dead. Continue injection @ 40 gpm under gravity flow. |

| | | |
|---|---|---|
| 5/31/89 | | Continue gravity flow injection at 40 gpm (all day). |
| | 1430 | Run sinker bar to 3800 feet - no obstructions |
| | 1530 | Run pressure - temperature survey. |
| 6/01/89 | 0730 | Run pressure - temperature survey<br>(continue gravity injection @ 40 gpm) |
| | 0900 | Remove top flange |
| | 1000 | Open wellhead and inspect<br>(continue water flow into well at ~20 gpm) |
| | 1130 | Mix high temperature cement (44 sacks Type I-II, 40% silica flour, 0.5% CFR-2, 0.25% HR-7).<br>(Cement mixed by Halliburton Engineer). |
| | 1230 | Work wiper plug into 9 5/8" casing. |
| | 1245 | Pump 65 cu ft. (150') cement plug through 3" annulus. |
| | 1300-1530 | Displace cement with 207 bbl. water. |
| 6/02/89 | 0900 | Inspect wellhead - no pressure. Plug holding. |
| | | Run pressure - temperature survey - land on plug at 3542 feet |
| 6/03/89 | 0800 | Add 20 bbl water. Shut-in and secure wellhead. |




Status of Kapoho State - 1A After Placemnet of

Temporary Cement Plug

June 1, 1989

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May 22, 1989
Reference No. 891413

Mr. William Paty
Chairman
Board of Land and Natural Resources
Kalanimoku Building, #130
1151 Punchbowl Street
Honolulu, Hawaii 96813

Subject: Well Modification Permit Request

Reference: Geothermal Well: Kapoho State #1-A
Geothermal Resources Mining Lease R-2
Location TMK 1-4-01:02 Kapoho, Puna District, Hawaii County Leased to Kapoho Land Partnership

Dear Mr. Chairman:

A Department of Land and Natural Resources (DLNR) permit exists for the drilling and completion of the reference well. Since the conclusion of drilling and flow testing in 1985, Kapoho State #1-A has been maintained in a shut-in status with periodical gas cap ventings and incineration or burning of the exhausted gases. Puna Geothermal Venture (PGV) has closely monitored this well and complied with DLNR reporting requirements.

Puna Geothermal Venture herewith submits a Well Modification Permit request consistent with Chapter 183 of Title 13, Subchapter 183-65-4.

The attached work description and well casing configuration drawing including the approximate location of the proposed cement plug is attached for reference.

In brief, the PGV request is based on a technical need to periodically service the wellhead assembly to maintain a high standard of reliability and integrity. This routine servicing process is also timed to fit within the overall 30 MW development schedule and expected County permitting approvals and related requirements now in progress.

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
☐ 610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125

Your early consideration and approval will be appreciated. Please contact the Hilo office of Puna Geothermal Venture if you or your staff have any questions about the above request.

Sincerely,

Maurice A. Richard
Hawaii Region
Development Manager

Attachment

MAR/ci

11 May 1989

Program to Temporarily Suspend KS-1A with Cement Plug

1) Purpose of Work

It will be at least a minimum of a year before KS-1A is needed for production service. Therefore PGV has decided to temporarily suspend the well by setting a 150 foot cement plug in the casing at 3000 feet. This will eliminate the need for further gas burns and will permit the wellhead to be serviced and the condition of the production casing to be checked in preparation for putting the well in service.

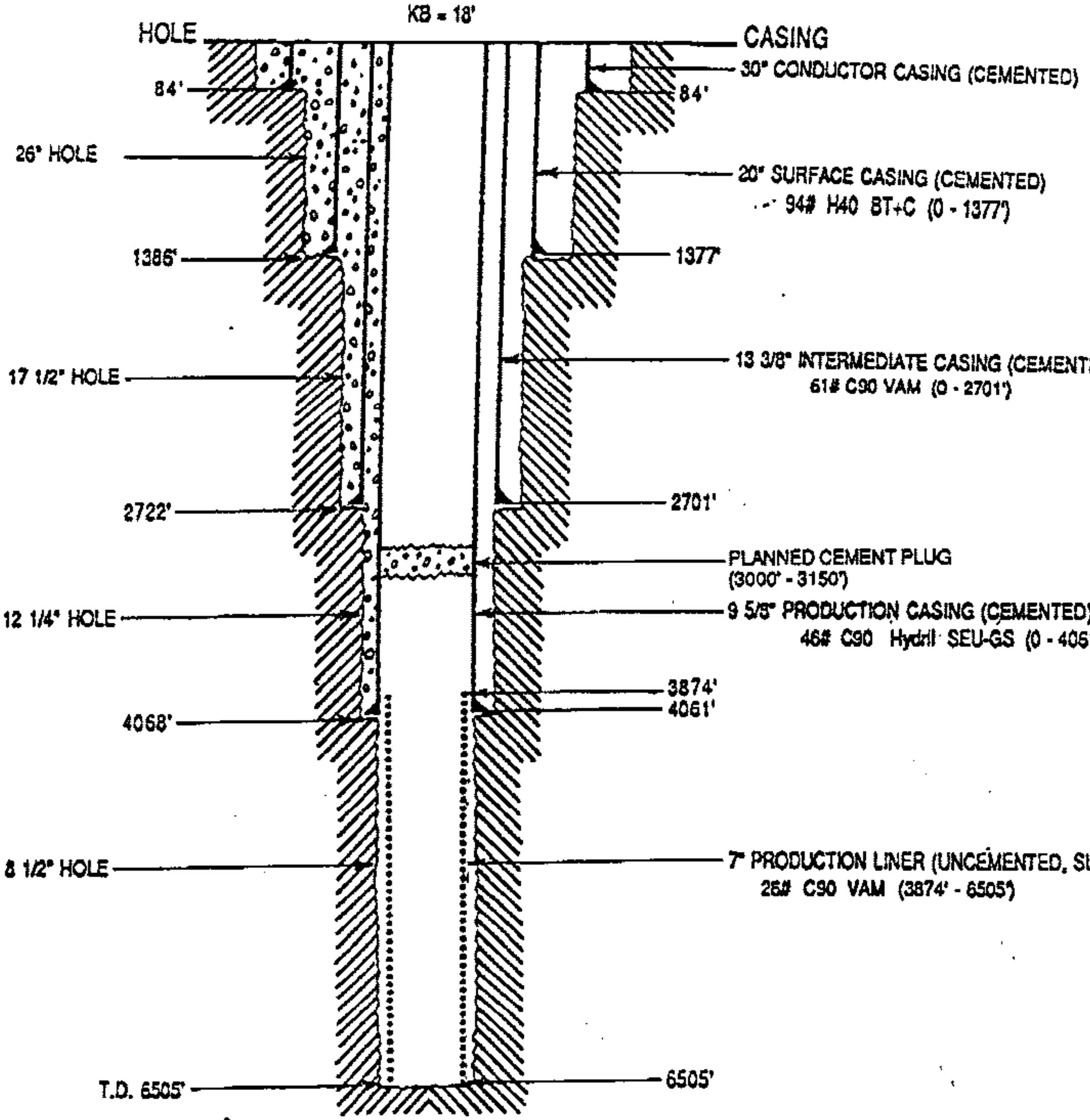
2) Plan of Work

The design of KS-1A showing the planned cement plug is shown in the attached figure. The setting depth of 3000 feet was chosen in order that the reservoir pressure beneath the plug will be balanced by the pressure exerted by the column of water in the wellbore above the plug. A rig will not be needed to carry out the work. The operation is planned as follows :

1. Run sinker bar to 4500 feet.
2. Run a static pressure and temperature survey to 4500 feet.
3. Nipple-up pump to 3" side valve and kill well by slowly pumping cold water.
4. With the well killed run an 8" gauge ring to 3500 feet. Continue to pump water to maintain kill.
5. Run temperature survey to 4000 feet while maintaining kill to assess wellbore temperatures for cement slurry design.
6. Insert 9 5/8" bottom wiper plug through wellhead.
7. Pump 75 gallons (25 liner feet) water on top of plug.
8. Mix 60 cu ft (150 liner feet) geothermal cement and drop on top of water.
9. Insert top wiper plug and displace cement plug to 3000 feet with water (220 barrels).
10. Wait on cement 24 hours.
11. Run sinker bar to top of cement to check depth.
12. Shut-in wellhead and secure.

The operation is anticipated to take a total of 5 to 7 days.

KAPOHO STATE #1A WELL




Planned Cement Plug in KS-1A

CONFIDENTIAL

THERMAL POWER COMPANY, OPERATOR

GEOTHERMAL WELL:
KAPOHO STATE 1-A

## PROPOSED DRILLING AND COMPLETION PROGRAM

1. Prepare second 10' x 10' x 10' cement-rebar wellhead cellar on existing location. Set 30" conductor pipe through cellar floor.

2. Move in Drilling Contractor's rig; drill and set rathole.

   (a) Notify Hawaii Board of Land and Material Resources (BLNR) 24 hours prior to commencement of drilling.

   (b) Confirm compliance with all permit requirements.

3. Spud hole with 12¼" bit and mud drilling fluid; drill to into top 20-feet of ground water zone in expected 600-700' depth interval. Stop and sample ground water.

4. Drill ahead to 1400' depth. Open 12¼" hole to 17½" and then to 26" Control lost circulation with LCM; cement severe lost circulation zones if required.

5. Run 20", 94 pound H-40 Buttress coupled casing to 1400'. Single stage Class G cement with 40% silica flour; use appropriate excess slurry. Be prepared to cement the 20-30" annulus with Redi-mix from the surface. W.O.C. 8 hours.

6. Land 20" casing. Weld on 21¼" 2000 psi wellhead.

   (a) Pressure test the weld.

   (b) Install B.O.P.E. consisting of a hydraulically-operated double ram blowout preventer with one set each of pipe and blind rams, an expansion-type annular preventer and a mud fillup line.

   (c) Notify the Chairman of the Hawaii Board of Land and Natural Resources (BLNR) in advance of B.O.P.E. test so that designated representative can witness the test.

   (d) Test each preventer, the stack, casing, kelly cock, master valve, check valves in kill line, and blowdown line valve to 1000 psig. Enter test results on contractor and operator daily reports.

CONFIDENTIAL

7. Install mud logging service at shoe of 20" casing before drilling out. Record continuous mud in and out temperatures, $H_2S$, $CH_4$, $CO_2$, lithology, and drilling rate. Have pit level indicator and intercom to drillers station. Catch four sets of 50 gpm dry sample every 20'. Make daily copies of the mud log, keeping one (1) copy up to date and spliced in trailer. Send five copies to:

   THERMAL POWER COMPANY
   601 California Street
   San Francisco, California 94108
   Attention: Joe Iovenitti

8. Drill 17½" hole to 2700' depth with mud drilling fluid. Survey wellbore every 200' or on bit change.

9. Run 13 3/8", 61 pound C-90 VAM coupled casing to 2700', with DV collar at 2500'.

   (a) First stage 400 annular feet of Class G cement with 40% silica flour.

   (b) Open DV collar, circulate out excess cement. W.O.C. 24 hours.

   (c) Tension 13 3/8" casing with jacks and set extended casing in wellhead slips.

   (d) Second stage a low density spherelite cement through DV collar. Use appropriate excess slurry to obtain uncontaminated cement returns. Close DV tool with wiper plug.

10. Remove B.O.P.E. Stub the 13 3/8" casing and nipple up 21¼" 2000 psi x 13 5/8 3000 psi casing spool.

   (a) Pressure test the wellhead.

   (b) Install B.O.P.E. consisting of one 12" Series 400 gate valve, a 12" mud cross with two side outlets for a kill line and a choke manifold, a hydraulically-operated double ram blowout preventer with one set each of pipe and blind rams, a 12" expansion-type annular preventer, and a mud fillup line. A rotating head may be added as directed.

   (c) Notify the Chairman of the Hawaii Board of Land and Natural Resources (BLNR) in advance of B.O.P.E. test so that designated representative can travel to the site and witness the test.

   (d) Test each preventer, the stack, casing, kelly cock, master valve, check valves in kill line, and blowdown line valve to 1000 psig. Record results on contractor and operator's daily reports.

   (e) Confirm drillsite location and operation of all $H_2S$ safety equipment. Put all drillsite personnel through $H_2S$ safety review including equipment downing by each person.

   (f) Confirm kelly cock installation and operation between kelly and swivel.

CONFIDENTIAL

11. Drill 12¼" hole to approximately 4100' depth with mud drilling fluid.

    (a) Survey hole at 500' intervals. Run maximum reading thermometers with each survey.

    (b) Continue mud logging as specified in 6(c) with special emphasis on temperature increases with depth.

12. Run 9 5/8", 47 pound, C-90, Hydril Triple Seal coupled production casing to bottom of 12¼" hole, with DV collar 200 feet above casing shoe.

    (a) Cool wellbore and first stage 400 annular feet of Class G cement with 40% silica flour.

    (b) Open DV collar, circulate out excess cement. W.O.C. 24 hours, cooling hole as directed.

    (c) Tension 9 5/8" casing with jacks and set extended casing in wellhead slips.

    (d) Second stage a low density spherelite cement through DV collar. Use appropriate excess slurry to obtain uncontaminated cement returns. Close DV tool with wiper plug.

13. Remove B.O.P.E. Stub the 9 5/8" casing as directed.

    (a) Install 13 5/8" x 11" 3000 psi expansion spool and 11" 3000 psi master valve.

    (b) Reinstall B.O.P.E. as in 10(b) above; notify BLNR as in 10(c) and test as in 10(d).

14. Drill 8 3/4" or 8½" hole, using fresh water as drilling fluid, to 6500 or 7500 foot total depth as directed. Flow testing of incremental intervals of production zone may be performed.

15. At total depth, hang or stand as directed, a drilled or slotted, 7", 26 pound, C-90, VAM coupled, production liner which is to be lapped 200 feet inside the 9-5/8" production casing.

16. Make a wireline run to bottom of 7" liner. Release rig and prepare for flow testing.

ATTACHMENT

CONFIDENTIAL

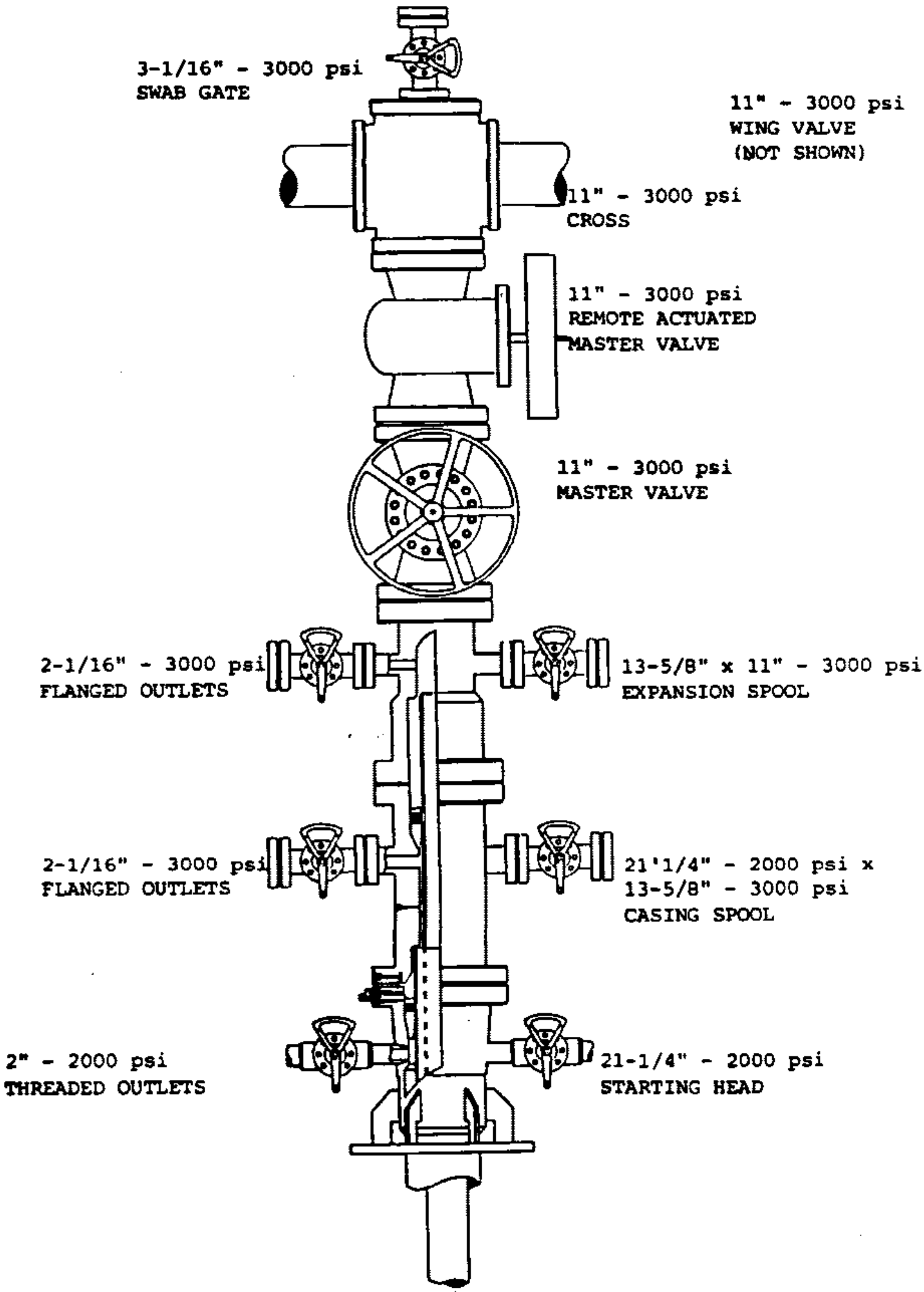
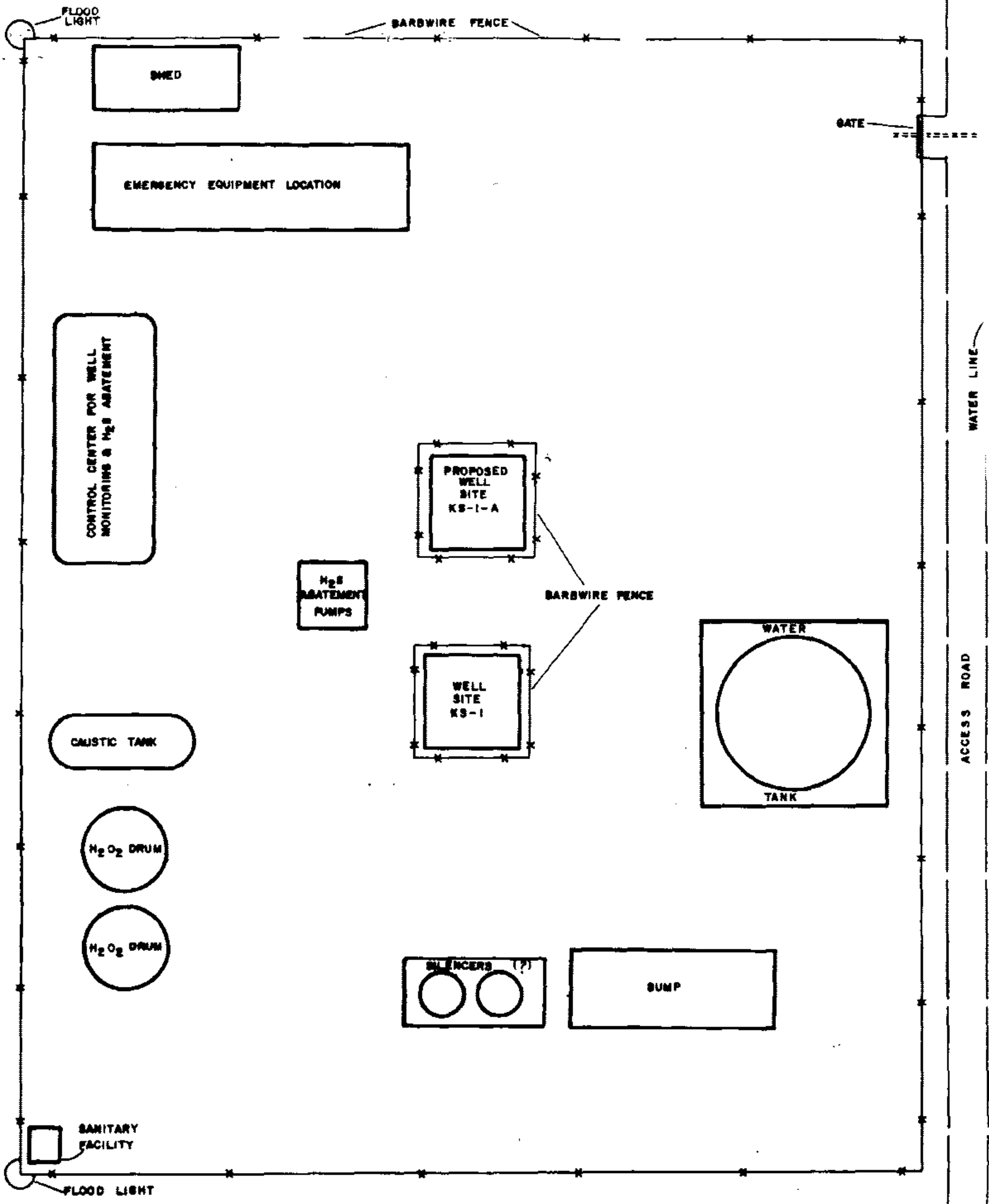



FIGURE 8

KAPOHO STATE #3 PROPOSED WELLHEAD DESIGN




N.T.P.
1/11/84
NOT TO SCALE

WL
S ons

ORMAT®



January 3, 1989 90
Reference No. 90002

Mr. William W. Paty
Chairperson
Board of Land and Natural Resources
P.O. Box 621
Honolulu, Hawaii 96809

Dear Mr. ~~Paty:~~ Bill

This letter is in response to your letter referenced WL-BM dated October 24, 1989.

As requested, the results of the temperature and pressure surveys conducted during the cement plugging operation are attached. Puna Geothermal Venture (PGV) considers this data proprietary and requests that the Department of Land and Natural Resources (DLNR) not disclose it to any third party without prior written approval from PGV.

As you know, bleeding and "burning" of the gases from the KS 1-A well had been conducted routinely on a two or three week basis from early 1986 until the time the cement plug was placed in the well in June 1989. Just prior to the gas burn of May 9, 1989, a few bubbles of gas were noted eminating from around the 20" casing at the floor of the cellar. At the time the stream was so small and irregular that the source and nature of the gas could not be conclusively determined. The bubbling ceased after the gas burn; however, as a precaution, it was decided to submit an application of the DLNR to modify the well should it be necessary sometime in the future.

The gas bubbling started again about two weeks later when the wellhead pressure reached about 480 psi. The stream increased as the wellhead pressure continued to increase and was found to be $H_2S$. Although the situation did not present a safety hazard, we believed it prudent to go set the cement plug as soon as possible.

The wellhead was inspected when opened during the plugging operation. This inspection, along with a review of the drilling records, suggests that the pack-off units in the 20"x13 3/8" and 13 3/8"x9 5/8" expansion spools began leaking as the pressure on the well increased above a threshold point, allowing gas to migrate into the 20" annulus. It was probably then leaking to the surface through the threads in the top joint of the 20" casing.

PUNA GEOTHERMAL VENTURE

☐ 101 Aupuni Street Suite 1014-B, Hilo, Hawaii 96720 • Telephone (808) 961-2184 • Facsimile (808) 961-3531
☐ 610 East Glendale Ave., Sparks, Nevada 89431-5811 • Telephone (702) 356-9111 • Facsimile (702) 356-9125

The cement plug has successfully isolated the reservoir from the surface. A rig and additional specialized equipment will be needed to repair the wellhead and, therefore, we believe it prudent to leave the well in the current condition until the necessary equipment is available.

We do not believe a casing pressure test is either necessary or prudent at this time due to the following:

1. The cement plug is holding an effective seal since no gas has accumulated in the wellhead since the plug was placed in early June;

2. The pressure applied during a casing pressure test will bleed off through the already known leak at the wellhead and thus will not be an effective test of the casing itself; and

3. A casing pressure test runs the risk of dislodging the plug in which case a rig would be immediately needed to set another plug (a second plug could not be run from the surface with the same confidence as the original plug). The equipment needed for this operation is not currently available.

In summary, we believe the well is currently in a safe and stable condition and we plan to maintain this condition (while continuing regular monitoring) until the necessary wellhead repairs can be made. A program detailing this repair work will be submitted to the DLNR prior to undertaking the repairs.

I trust this letter addresses the queries and concerns expressed in your letter. Please call me if you have any questions or need additional information.

Sincerely,

Maurice A. Richard
Regional Development Manager

Attachment

MAR/ci

Report On Temporarily Suspending Well KS-1A

With A Cement Plug

June 1, 1989

## 1. Summary

A cement plug was successfully placed between 3542 feet and 3692 feet in KS-1A on June 1, 1989. The current status of the well is shown in the attached figure. The cement plug has isolated the surface from the geothermal reservoir and has eliminated the need to conduct $H_2S$ gas burns.

A casing pressure test was not carried out at the time the plug was set in order to give it sufficient time to develop full strength. Also, a pressure test runs the risk of dislodging the plug in which case a rig and additional pumping and cementing equipment would be needed to remedy the situation. This equipment was not available at the time and therefore it was believed prudent not to conduct the pressure test.

In lieu of the pressure test the well condition is being monitored on a regular basis for evidence of a casing leak.

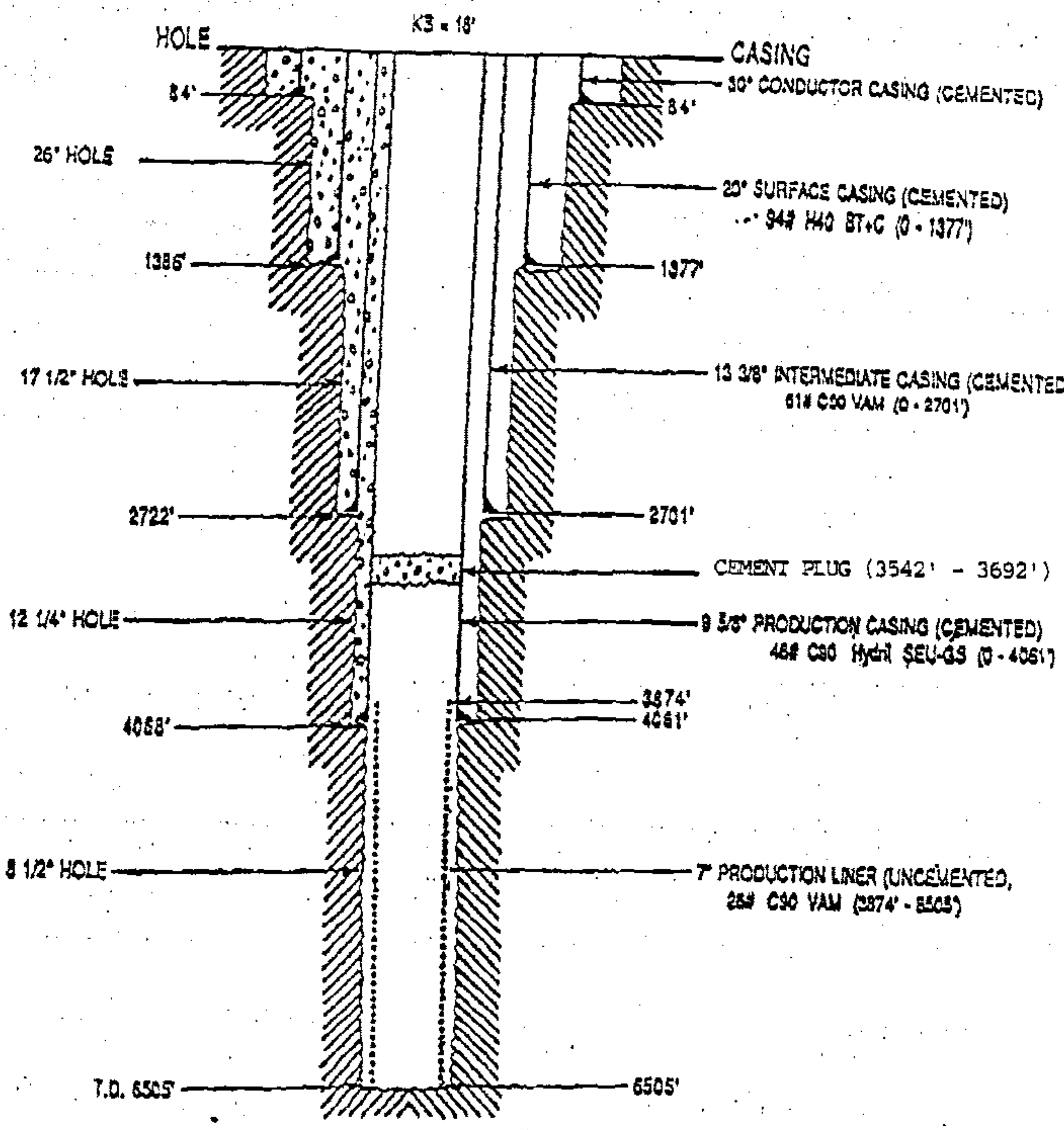
A leak through the cement plug would allow gas to percolate from the reservoir up the well and would be evidenced as a build-up in wellhead pressure. No build-up has been observed during the 3 months since the well was plugged.

Alternatively, a leak in the casing above the cement plug would cause the water level inside the well to equilibrate with the ground water level which is about 600 feet below the surface in this location. The water level in the well is currently stable at about 220 feet below the surface which indicates the casing above the plug is sound.

## 2. Chronology of Operation

| | | |
|---|---|---|
| 5/30/89 | 0700 | Commence gas burn from initial pressure of 380 psig. |
| | 1040 | Fluid at surface, WHP = 285 psig.<br>Start water kill @ 16 gpm. |
| | 1600 | Continue kill. WHP = 110 psig, Q = 25 gpm. |
| | 2200 | Well dead. Continue injection @ 40 gpm under gravity flow. |

| | | |
|---|---|---|
| 5/31/89 | | Continue gravity flow injection at 40 gpm (all day). |
| | 1430 | Run sinker bar to 3800 feet - no obstructions |
| | 1530 | Run pressure - temperature survey. |
| 6/01/89 | 0730 | Run pressure - temperature survey<br>(continue gravity injection @ 40 gpm) |
| | 0900 | Remove top flange |
| | 1000 | Open wellhead and inspect<br>(continue water flow into well at ~20 gpm) |
| | 1130 | Mix high temperature cement (44 sacks Type I-II, 40% silica flour, 0.5% CFR-2, 0.25% HR-7).<br>(Cement mixed by Halliburton Engineer). |
| | 1230 | Work wiper plug into 9 5/8" casing. |
| | 1245 | Pump 65 cu ft. (150') cement plug through 3" annulus. |
| | 1300-1530 | Displace cement with 207 bbl. water. |
| 6/02/89 | 0900 | Inspect wellhead - no pressure. Plug holding. |
| | | Run pressure - temperature survey - land on plug at 3542 feet |
| 6/03/89 | 0800 | Add 20 bbl water. Shut-in and secure wellhead. |




Status of Kapono State - 1A After Placemnet of

Temporary Cement Plug

June 1, 1989

Diamond Shamrock
Thermal Power Company

Ralph A. Patterson, Jr.
Hawaii Project Manager

27 January 1988

Mr. William W. Paty
Chairperson, Board of
Land and Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

**Re: Application for Permit to Modify Well KS-1A State Geothermal Mining Lease R-2 Puna District, Hawaii County**

Dear Mr. Paty:

In accordance with DLNR Administrative Rule, Title 13, Subchapter 183-65 and our approved Amendment to Plan of Operations dated 1 December 1986, Thermal Power Company as Operator for the Puna Geothermal Venture submits herewith an Application for Permit to Modify Well KS-1A on the referenced lease. As previously reported to the DLNR, KS-1A was originally drilled as a vertical wellbore to 6505 feet in September 1985. After subsequent testing of geothermal fluids, KS-1A has been maintained with the wellhead valves shut pending the completion of various pre-conditions contained in the agreement to conduct a long-term flow test using the HGP-A facility. The well has been kept in a safe and secure condition by the periodic burning off of the gas cap that forms at the top of the wellbore, and by the addition of a corrosion-inhibiting mixture to the wellbore, thus keeping pressures in the well at or below those recommended by our technical staff.

Thermal now proposes to install a drillable cement plug in the wellbore at about 3000 feet below the wellhead, and to then fill the wellbore above the plug with a corrosion-inhibiting fluid mixture. This procedure will provide increased protection for the installed casing and will eliminate the need for the periodic gas burns. The plug can be drilled out to restore the well to its production configuration.

A $100 non-refundable filing fee is enclosed. Other enclosures include a drawing of the proposed KS-1A wellbore modification, a description of the proposed procedure, and maps of the R-2 lease area.

An early consideration and approval of the Permit to Modify Well KS-1A will be appreciated in order to allow the orderly procurement of materials and services in time to complete the plug installation in mid-February. Please contact me if there are any questions.

Sincerely yours,

Ralph A. Patterson

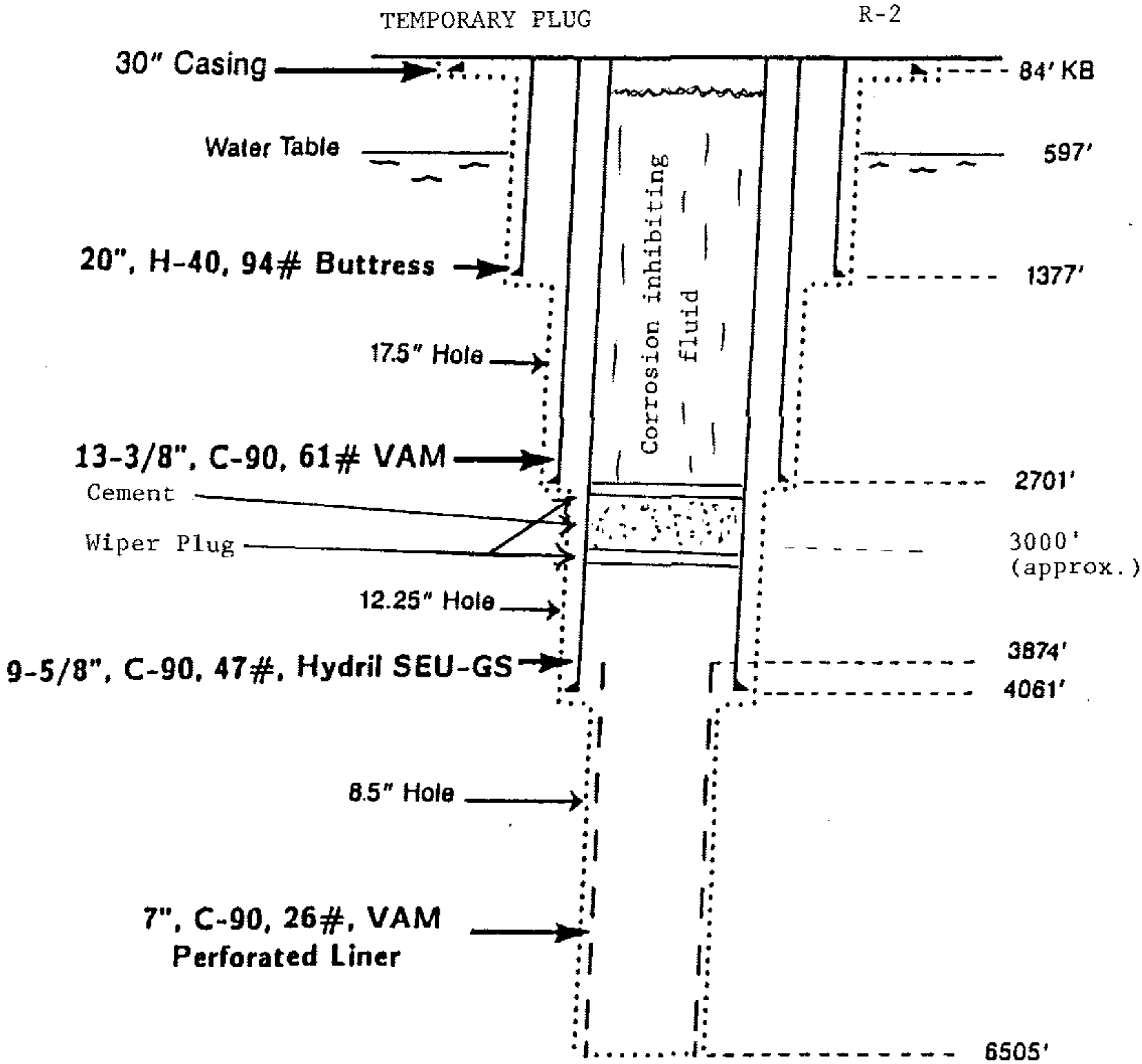
encl
RAP/cn/0429A

PUNA GEOTHERMAL VENTURE

# WELLBORE SCHEMATIC KS-1A

THERMAL POWER COMPANY
OPERATOR

GEOTHERMAL
MINING LEASE
R-2




**Spud Date: 8 July 1985**
**Date of Completion: 3 September 1985**

KS-1A WELLBORE DIAGRAM

Revised January 1988

PUNA GEOTHERMAL VENTURE

THERMAL POWER COMPANY, OPERATOR

Procedure to set plug in KS-1A

1. Burn gases and then pump water at 14 gpm to cool the well for about 8 hours.
2. Increase flow rate by 7 gpm after each 4 hours and continue pumping till WHP is zero.
3. Flow water into KS-1A under gravity till temperature at 3000' is below $200^{0}$F. Water level is expected at about 600' depth at this time.
4. Insert 9 5/8" wiper plug at wellhead and push it down in 9 5/8" casing. (Note: wiper plug will go through non concentric casing at the top due to its flexible sides).
5. Mix 250 linear feet of cement with 40% silica flour, 3% gel and 0.5% CFR-2.. (All of this except cement is available at HT&T yard). Slurry weight 15.5 lbs per gallon. Batch mix cement in ready mix truck and pump with B. J. cement pump through 3" side valve.
6. Put another 9 5/8" wiper plug at well head and displace cement to 3000' depth. Displace it with 220 bbls of amine water. This volume of water will determine the depth of the plug.

Calculations

| | | |
|---|---|---|
| casing volume per foot | = | 0.411 cuft/ft |
| volume of 250 linear ft cement | = | 250 x .411 = 102.76 cuft |

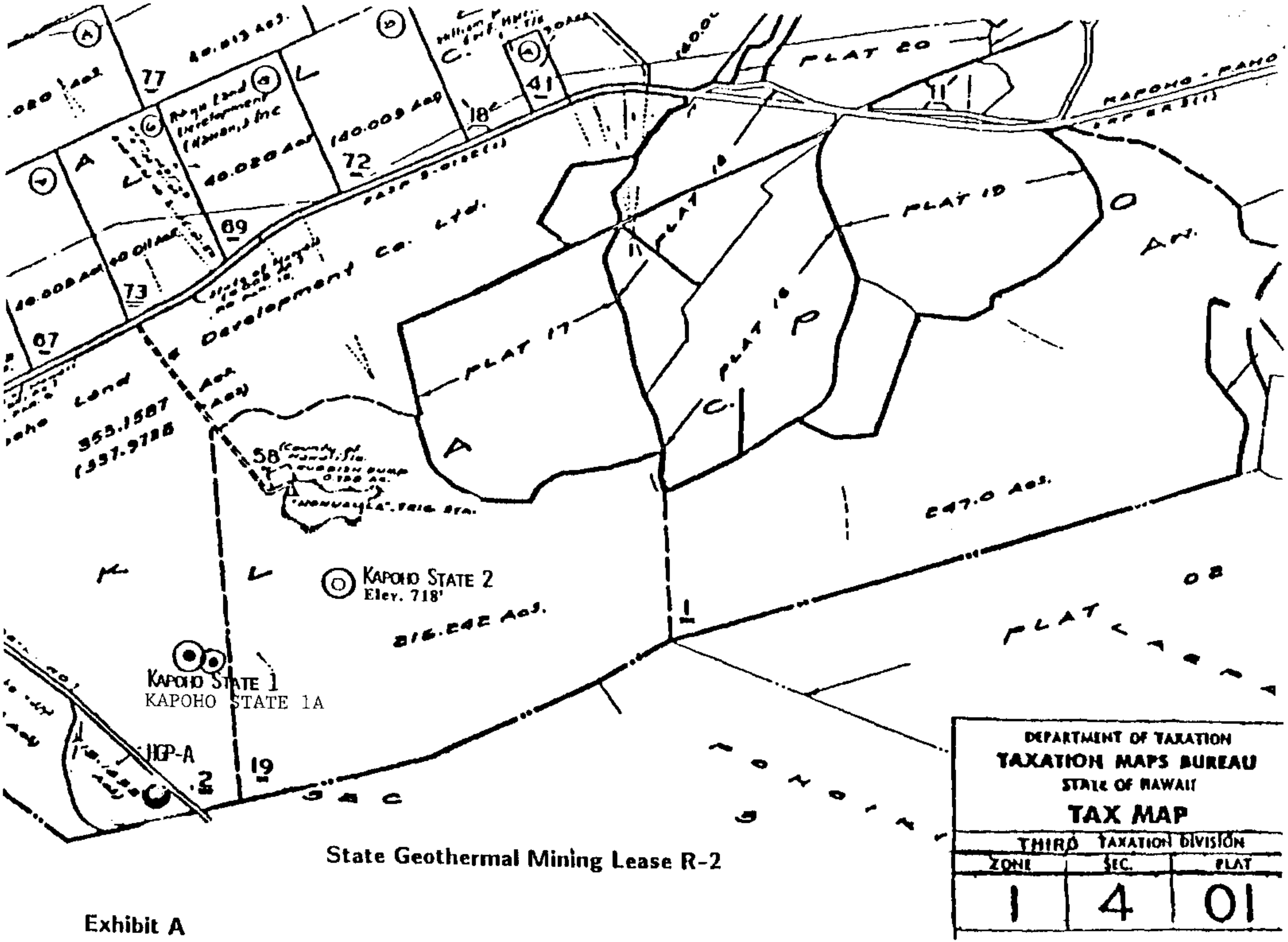
for 40% $SiO_2$ flour, class G, 15.5 lbs/gal slurry, one sack of cement produces 1.62 cuft of slurry volume (Red book, p.68).

number of sacks = $\frac{102.76}{1.62}$ = 63.43 sacks

so 65 sacks of cement needed.

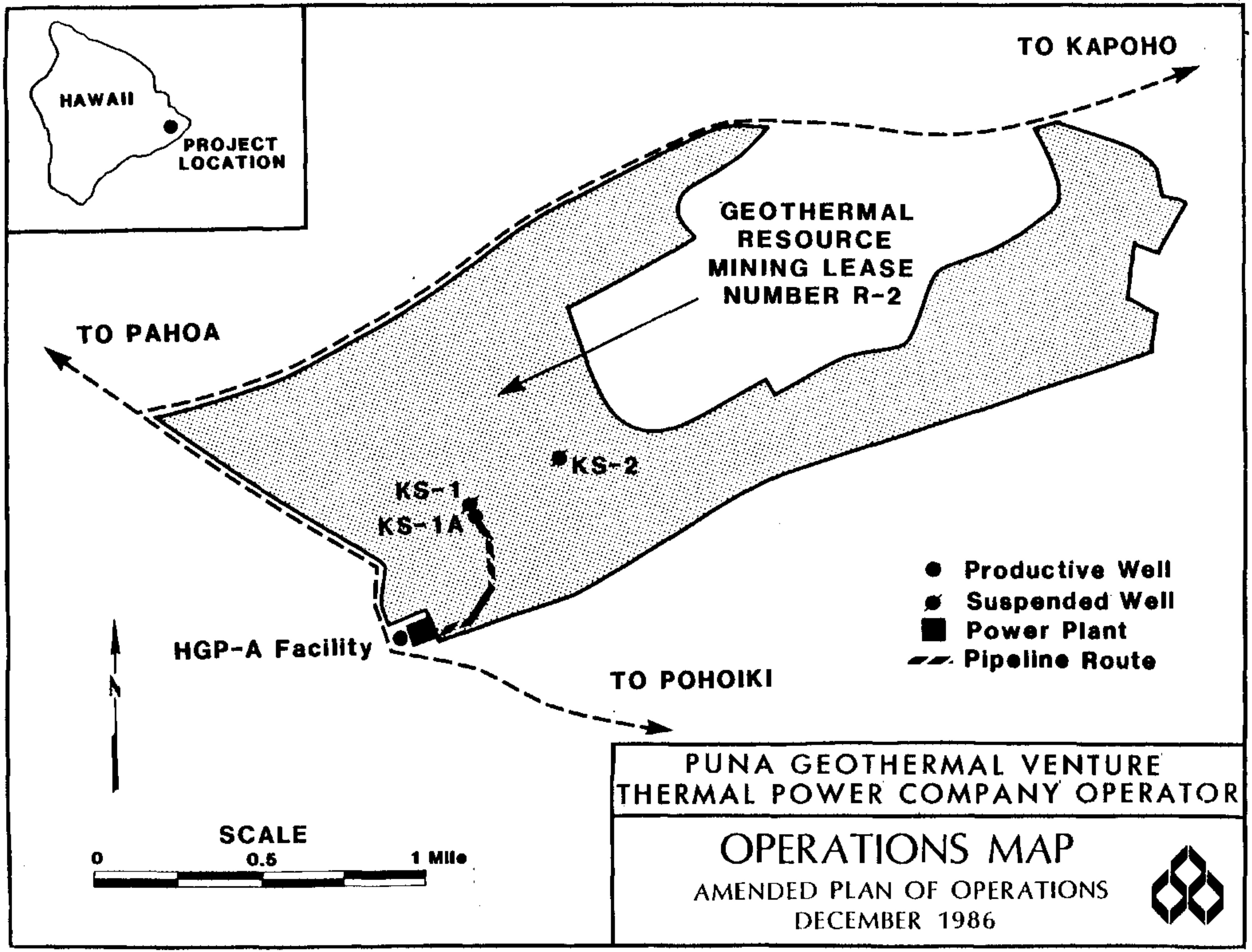
water requirement = 6.8 x 65 = 442 gallons of water needed to mix cement.
3000' ft to displacement = 0.411 x 3000 = 1233 cuft = 220 bbls
cement density = 94/lbs/cuft = 94 lbs/sk
weight of cement = 94 x 65 = 6110 lbs.
3% Gel (by weight) = 0.03 x 6110 = 183.3 lbs.
0.5% CFR-2 (by weight) = 0.005 x 6110 = 30.55 lbs.
70 lbs of $SiO_2$ flour = 1 cuft
volume of 40% $SiO_2$ flour = 65 cuft cement x 0.4 = 26 cuft
weight of $SiO_2$ flour = 26 x 70 = 1820 lbs.

January 1988




State Geothermal Mining Lease R-2

Exhibit A


HAWAII
PROJECT LOCATION
TO KAPOHO
GEOTHERMAL RESOURCE MINING LEASE NUMBER R-2
TO PAHOA
KS-2
KS-1
KS-1A
HGP-A Facility
TO POHOIKI
Productive Well
Suspended Well
Power Plant
Pipeline Route
SCALE
0
0.5
1 Mile
PUNA GEOTHERMAL VENTURE
THERMAL POWER COMPANY OPERATOR
OPERATIONS MAP
AMENDED PLAN OF OPERATIONS
DECEMBER 1986

**Diamond Shamrock**

Thermal Power Company

**Ralph A. Patterson, Jr.**
Hawaii Project Manager

30 December 1985

Mr. Albert L. Lyman
Planning Director
County of Hawaii
25 Aupuni Street
Hilo, Hawaii 96720

Dear Mr. Lyman:

In accordance with the instructions in your letter of 10 September 1985 and our "KS-1A Well Test Monitoring Plan" dated 5 September, 1985, the following report of monitoring and recording of emissions and water catchment samples is forwarded.

The KS-1A well was vented for approximately four hours on 14 October, and intermittently over a seven-hour period on 30 October.

Specific items of the plan are detailed below.

1. Notification. - Members of the Youth Group of the Puna Baptist Mission distributed approximately 500 flyers on the open venting schedule during the first week in October. In addition, announcements of the venting were published in the Hawaii Tribune-Herald (13 and 29 October), the Honolulu Advertiser, and Honolulu Star Bulletin. Radio announcements were broadcast on Hilo stations on 14 October and 30 October.

2. Catchment system tests. - Samples of local water catchment systems were taken before initial venting on 11 October, and again on 4 November. Some changes in the residences sampled from past tests were necessary because of people moving, etc. A list of the residences sampled and the results of the laboratory analyses is attached. Results will also be provided to the residents whose systems were tested.

3. Noise. - Special noise monitoring was conducted at the site and at the other monitoring points in the area. A summary of the noise readings before, during and after the venting events is attached.

4. Air Emissions. - Data gathered at the various stations in the well site vicinity is attached.

Mr. Albert L. Lyman
Page Two
30 December 1985

5. Meteorology stations. - Data is attached.

6. Plume size and dispersal. - During the venting on 14 October and again on 30 October, the plume from the well reached a height of approximately 200 feet, depending on the wind speed and direction. At the beginning of the 14 October event, the wind speed was generally from the north; during the test the wind veered about 90 degrees. Wind speed was light, estimated at 5-12 knots during the venting. On 30 October, winds were light and variable, estimated at 5-8 knots and generally from a northerly direction.

Thermal Power Company considers that the flow test of the KS-1A well proceeded very well, with no interruptions for repairs or unexpected events. A complete set of quality data was obtained from the well testing. Analysis of this data now underway is expected to greatly increase our knowledge of the reservoir and of the well configuration and mechanics.

If there are any questions, please contact me.

Sincerely yours,

Ralph A. Patterson Jr

Encl

RAP/crn

cc: DOWALD, Tobias, D'Olier, Nakaji, Pittenger, Bowden, Goyal

LymMonRp

Catchment Systems Testing

11 October and 4 November, 1985

Residences Sampled:

1. Arnold Moses
   SR28
   Pahoa, HI 96778

2. Greg Pommerenk
   P. O. box 1588
   Pahoa, HI 96778

3. Tom Zoeteway
   P. O. Box 1187
   Pahoa, HI 96778

4. Jeane R. Kubera
   P. O. Box 776
   Pahoa, HI 96778

5. David Hess
   P. O. Box 632
   Pahoa, HI 96778

6. Janet Woods
   P. O. box 895
   Pahoa, HI 96778

**INDUSTRIAL ANALYTICAL LABORATORY, INC.**

1523 Kalakaua Avenue • Suite 207 • Honolulu, Hawaii 96826 • (808) 947-5402

*An AIHA / NIOSH Accredited Industrial Hygiene Laboratory*
*Certification No. 154*

# LABORATORY REPORT

*INALAB*

Thermal Power Company
Central Pacific Plaza
220 South King Street, Suite 1750
Honolulu, Hawaii 96813

REPORT DATE: 10/31/85
ANALYST: Irene Enoki
INVOICE No.: 7006
P.O. No.: 7417

Attention: Ralph Patterson (524-8940)

DATE SAMPLE SUBMITTED: 10/17/85
DATE SAMPLE ANALYZED: 10/20 - 10/30/85
SAMPLE SUBMITTED BY: Mr. Patterson

Six aqueous samples were submitted for determination of mercury (Hg), arsenic (As), and lead (Pb) concentration. The results are presented below.

| | | (ANALYTE/units) | | |
|---|---|---|---|---|
| | | Concentration | | |
| INALAB Number | Your Sample Description | Pb µg/L | As µg/L | Hg µg/L |
| 851017-01 | Zoetency (Redwood/Copper) | <50* | <1* | <1* |
| -02 | Moses (Steel/Copper) | <50 | <1 | <1 |
| -03 | Woogs (Vinyl Limer) | <50 | <1 | <1 |
| -04 | Hess (Concrete/Hollow) | <50 | <1 | <1 |
| -05 | Pommerenk (Redwood/PVC) | <50 | <1 | <1 |
| -06 | Kijbera (Hollow Tile) | <50 | <1 | <1 |

*Detection Limit.

REFERENCE:

Standard Method for Examination of Water and Wastes, 16th Ed., 1985.

COMMENTS:

(1) Samples were not collected by INALAB personnel.
(2) Samples will be retained by the laboratory for a maximum of 30 days. Unless otherwise requested in writing they will then be discarded.

FOR INDUSTRIAL ANALYTICAL LABORATORY, INC.

Michael K.W. Li

Dr. Michael K.W. Li
Vice President/Operations

SEAL

Mark R. Hagadone

Mark R. Hagadone
Vice President, Director

# INDUSTRIAL ANALYTICAL LABORATORY, INC.

1523 Kalakaua Ave • Suite 207 • Honolulu, Hav 96826 • (808) 947-5402

*An AIHA / NIOSH Accredited Industrial Hygiene Laboratory*
*Certification No. 154*

INALAB


## LABORATORY REPORT

Thermal Power Company
Central Pacific Plaza
220 South King Street, Suite 1750
Honolulu, Hawaii 96813

REPORT DATE: 12/2/85
ANALYSTS: Irene Enoki
Dwight Fujiwara
INVOICE NO: 7120
P.O. NO: 7417

ATTENTION: Mr. Ralph Patterson
524-8940

DATE SAMPLES SUBMITTED: 11/6/85
DATES SAMPLES ANALYZED: 11/10 - 11/22/85

Six aqueous samples were submitted for determination of total mercury (Hg), arsenic (As), and lead (Pb) concentration. The results are presented below.

| INALAB Number | Your Sample Number/ Description | Pb mg/L | As mg/L | Hg mg/L |
|---|---|---|---|---|
| 851106-17 | Moses | <0.05* | <0.001* | <0.002* |
| -18 | Hess | 0.08 | <0.001 | <0.002 |
| -19 | Kobera | <0.05 | <0.001 | <0.002 |
| -20 | Pommerenk | <0.05 | <0.001 | <0.002 |
| -21 | Woods | <0.05 | <0.001 | <0.002 |
| -22 | Zoetenzy | <0.05 | <0.001 | <0.002 |

* = Detection Limit.

REFERENCE: Standard Method for Examination of Water and Wastes, 16th Ed., 1985.

COMMENTS: (1) Samples were not collected by INALAB personnel.
(2) Samples will be retained by the laboratory for a maximum of 30 days. Unless otherwise requested in writing they will then be discarded.

FOR INDUSTRIAL ANALYTICAL LABORATORY, INC.

Dr. Michael K.W. Li
Vice President/Operations

Mark R. Hagadone
Vice President, Director

Noise Level Stations are located in reference to HGP-A Well Site.

| | | | | |
|---|---|---|---|---|
| Station #1 | Rift | .5 mi. | E | of HGP-A |
| 2 | Schroeders Hill | 1.1 mi. | SW | " |
| 3 | Fire Hydrant | .5 mi. | SE | " |
| 4 | Drill Site | .6 mi. | NE | " |
| 5 | Colortec #35 | .4 mi. | NW | " |
| 6 | Drill Site Gate | .3 mi. | ENE | " |
| 7 | Visitors Center | | | on Site |
| 8 | Colortec #38 | .7 mi. | NNW | of HGP-A |
| 9 | Colortec #13 | 1.0 mi. | W | " |

Noise Levels during month of October, 1985

| Sta.# | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | Avg |
|---|---|---|---|---|---|---|---|---|---|---|
| Date | | | | | | | | | | |
| 1004 | 39 | 36 | 37 | 49 | 38 | 41 | 38 | 37 | 37 | 39 |
| 1007 | 35 | - | - | 38 | 35 | - | - | 38 | - | 37 |
| 1009 | 38 | 36 | 39 | 46 | 39 | 40 | 52 | 36 | 37 | 40 |
| 1011 | 46 | 39 | 40 | 72 | 41 | 39 | 42 | 35 | 35 | 43 |
| 1014 | 79 | 80 | 59 | 115 | 55 | 58 | 73 | 52 | 44 | 68 |
| | 75 | 73 | 54 | 105 | 51 | 77 | 70 | 48 | 43 | 61 |
| 1016 | 38 | 35 | 36 | 55 | 36 | 37 | 51 | 35 | 35 | 40 |
| 1018 | 38 | 37 | 37 | 56 | 39 | 37 | 53 | 37 | 37 | 41 |
| 1021 | 36 | 36 | 36 | 55 | 36 | 37 | 52 | 35 | 36 | 40 |
| 1023 | 39 | 38 | 36 | 66 | 35 | 35 | 52 | 35 | 36 | 41 |
| 1025 | 37 | 35 | 35 | 61 | 35 | 39 | 52 | 38 | 36 | 41 |
| 1028 | 39 | 37 | 36 | 55 | 36 | 37 | 52 | 36 | 35 | 40 |
| 1030 | 39 | 36 | 36 | 60 | 35 | 38 | 53 | 35 | 37 | 41 |
| | 73 | 64 | 66 | 108 | 65 | 75 | 73 | 41 | 55 | 69 |
| 1101 | 40 | 44 | 38 | 43 | 42 | 43 | 53 | 41 | 38 | 42 |
| Avg. | 46 | 45 | 42 | 66 | 41 | 45 | 55 | 39 | 39 | 46 |

All readings are in Decibels

DAILY AVERAGE, MAXIMUM AND TOTAL $H_2S$ READINGS FOR HGP-A

October 1 to October 31, 1985

| | Fenceline | | | Schroeders | | | Gilman | | | Woods | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ate | Avg | Max | Total | Avg | Max | Total | Avg | Max | Total | Avg | Max | Total |
| 001 | 7 | 9 | 178 | 3 | 5 | 79 | 1 | 5 | 27 | 2 | 4 | 48 |
| 002 | 11 | 18 | 264 | 3 | 6 | 72 | 2 | 8 | 47 | 3 | 4 | 62 |
| 003 | 9 | 12 | 212 | 2 | 5 | 76 | 4 | 7 | 89 | 3 | 4 | 67 |
| 004 | 10 | 15 | 234 | 4 | 9 | 103 | 2 | 7 | 55 | 2 | 5 | 57 |
| 005 | 11 | 14 | 256 | 3 | 5 | 82 | 0 | 1 | 1 | 3 | 4 | 64 |
| 006 | 8 | 12 | 190 | 4 | 6 | 93 | - | - | - | 2 | 4 | 46 |
| 007 | 9 | 21 | 221 | 2 | 6 | 59 | 3 | 7 | 60 | 2 | 4 | 54 |
| 008 | 3 | 5 | 49 | - | - | - | 5 | 7 | 120 | 1 | 3 | 34 |
| 009 | 3 | 12 | 136 | - | - | - | 4 | 7 | 87 | 2 | 4 | 54 |
| 010 | 9 | 10 | 211 | - | - | - | 2 | 4 | 45 | 2 | 4 | 39 |
| 011 | 8 | 10 | 180 | 2 | 4 | 41 | 3 | 5 | 67 | 1 | 2 | 13 |
| 012 | 7 | 9 | 178 | 3 | 5 | 82 | 4 | 6 | 106 | 1 | 3 | 30 |
| 013 | 7 | 9 | 178 | 4 | 6 | 94 | 4 | 5 | 103 | 1 | 3 | 20 |
| 014 | 12 | 17 | 284 | 3 | 4 | 75 | 4 | 4 | 84 | 1 | 2 | 31 |
| 015 | 15 | 19 | 355 | 3 | 4 | 74 | 3 | 4 | 75 | 1 | 3 | 21 |
| 016 | 9 | 16 | 218 | 3 | 6 | 71 | 3 | 5 | 76 | 2 | 4 | 37 |
| 017 | 6 | 11 | 155 | 4 | 6 | 91 | 3 | 4 | 71 | 2 | 3 | 44 |
| 018 | 8 | 17 | 199 | 4 | 6 | 101 | 3 | 4 | 83 | 3 | 4 | 67 |
| 019 | 5 | 11 | 46 | 6 | 7 | 132 | 4 | 5 | 97 | 2 | 3 | 47 |
| 020 | - | - | - | 6 | 8 | 148 | 4 | 5 | 96 | 2 | 3 | 41 |
| 021 | 1 | 10 | 77 | 2 | 6 | 55 | 4 | 5 | 85 | 1 | 3 | 33 |
| 022 | - | - | - | 3 | 5 | 74 | 4 | 5 | 85 | 2 | 4 | 58 |
| 023 | - | - | - | 4 | 7 | 93 | 3 | 5 | 66 | 2 | 4 | 44 |
| 024 | - | - | - | 4 | 5 | 93 | 3 | 4 | 65 | 1 | 2 | 27 |
| 025 | 5 | 15 | 127 | 3 | 5 | 83 | 3 | 5 | 79 | 2 | 3 | 36 |
| 026 | 6 | 11 | 142 | 4 | 5 | 97 | 3 | 4 | 71 | 1 | 3 | 33 |
| 027 | 7 | 11 | 160 | 4 | 5 | 92 | 3 | 7 | 77 | 2 | 4 | 54 |
| 028 | 6 | 9 | 134 | 3 | 4 | 70 | 3 | 4 | 66 | 2 | 3 | 45 |
| 029 | 6 | 8 | 135 | 3 | 4 | 75 | 3 | 5 | 78 | 2 | 3 | 38 |
| 030 | 5 | 7 | 108 | 3 | 4 | 65 | 3 | 4 | 64 | 2 | 4 | 36 |
| 031 | 6 | 12 | 149 | 3 | 4 | 61 | 3 | 5 | 70 | 2 | 5 | 49 |
| | 6 | 21 | 4773 | 3 | 9 | 2321 | 3 | 8 | 2191 | 2 | 5 | 1255 |

l readings are in parts per billion (ppb)

Synopsis of Average Daily Meterological Station Readings

10/1985

T. P. MET

| DAY | TEMP | WD | WS |
|---|---|---|---|
| 01 | 21.7 | 344 | 4.5 |
| 02 | 22.2 | 9 | 3.6 |
| 03 | 22.0 | 350 | 3.2 |
| 04 | - | - | - |
| 05 | 22.6 | 355 | 5.8 |
| 06 | 23.3 | 27 | 4.5 |
| 07 | 22.8 | 31 | 4.7 |
| 08 | 24.2 | 85 | 7.6 |
| 09 | 23.1 | 22 | 4.6 |
| 10 | 22.7 | 21 | 4.8 |
| 11 | 21.3 | 352 | 4.6 |
| 12 | 22.5 | 361 | 4.8 |
| 13 | 23.2 | 19 | 4.4 |
| 14 | 23.0 | 13 | 5.3 |
| 15 | 22.5 | 351 | 4.9 |
| 16 | 23.2 | 73 | 4.5 |
| 17 | 23.0 | 204 | 7.3 |
| 18 | 23.6 | 217 | 8.2 |
| 19 | 24.6 | 299 | 5.5 |
| 20 | 24.5 | 40 | 5.2 |
| 21 | 23.9 | 29 | 5.1 |
| 22 | 23.3 | 12 | 4.5 |
| 23 | 23.3 | 33 | 5.0 |
| 24 | 23.0 | 93 | 5.5 |
| 25 | 23.2 | 51 | 4.8 |
| 26 | 22.8 | 23 | 4.1 |
| 27 | 22.9 | 24 | 5.5 |
| 28 | 22.8 | 9 | 9.0 |
| 29 | 21.8 | 11 | 6.1 |
| 30 | 22.9 | 32 | 5.2 |
| 31 | 21.6 | 355 | 6.7 |
| AVG | 22.9 | 8 | 5.3 |
| MAX | 24.6 | - | 9.0 |
| MIN | 21.3 | - | 3.2 |
| TOT | | | |

WOODS MET

| DAY | TEMP | WD | WS | RAD | RAIN | RH | SIGMA |
|---|---|---|---|---|---|---|---|
| 01 | 22.0 | 305 | 5.4 | 202 | 0.57 | 91 | 16.8 |
| 02 | 22.8 | 313 | 4.7 | 256 | 0.02 | 80 | 14.2 |
| 03 | 22.0 | 292 | 4.2 | 166 | 0.00 | 83 | 14.3 |
| 04 | 23.1 | 306 | 7.9 | 322 | 0.00 | 77 | 18.8 |
| 05 | 22.9 | 324 | 6.1 | 114 | 0.38 | 87 | 15.3 |
| 06 | 23.9 | 4 | 4.9 | 236 | 0.05 | 79 | 19.2 |
| 07 | 22.7 | 341 | 4.5 | 96 | 0.10 | 91 | 16.4 |
| 08 | 24.3 | 57 | 7.8 | 142 | 0.00 | 80 | 14.5 |
| 09 | 22.8 | 352 | 4.9 | 116 | 0.19 | 85 | 16.5 |
| 10 | 22.6 | 332 | 5.7 | 228 | 0.02 | 81 | 17.1 |
| 11 | 21.0 | 301 | 5.4 | 144 | 0.31 | 93 | 15.7 |
| 12 | 22.0 | 306 | 5.5 | 324 | 0.09 | 82 | 15.5 |
| 13 | 22.3 | 313 | 4.7 | 214 | 0.21 | 87 | 13.3 |
| 14 | 22.8 | 320 | 5.3 | 180 | 0.31 | 93 | 14.7 |
| 15 | 22.6 | 287 | 4.5 | 234 | 0.07 | 88 | 14.4 |
| 16 | 23.0 | 15 | 5.0 | 290 | 0.23 | 84 | 11.1 |
| 17 | 23.3 | 345 | 6.6 | 88 | 0.57 | 97 | 10.4 |
| 18 | 23.6 | 307 | 6.3 | 52 | 0.15 | 91 | 14.1 |
| 19 | 24.3 | 319 | 5.2 | 170 | 0.58 | 94 | 13.4 |
| 20 | 24.4 | 17 | 4.7 | 176 | 0.24 | 92 | 12.2 |
| 21 | 22.5 | 357 | 4.6 | 164 | 0.05 | 86 | 15.7 |
| 22 | 22.9 | 315 | 4.4 | 173 | 0.05 | 87 | 16.2 |
| 23 | 22.9 | 346 | 5.3 | 225 | 0.09 | 85 | 16.7 |
| 24 | 22.8 | 46 | 5.9 | 62 | 0.90 | 96 | 14.4 |
| 25 | 23.1 | 4 | 5.4 | 168 | 0.16 | 86 | 14.7 |
| 26 | 22.9 | 333 | 4.5 | 124 | 0.03 | 86 | 15.7 |
| 27 | 23.1 | 337 | 6.5 | 182 | 0.09 | 87 | 17.1 |
| 28 | 23.0 | 339 | 9.4 | 304 | 0.01 | 66 | 20.6 |
| 29 | 21.9 | 334 | 7.3 | 220 | 0.26 | 82 | 17.0 |
| 30 | 22.3 | 348 | 6.2 | 218 | 0.03 | 75 | 18.8 |
| 31 | 21.3 | 310 | 6.8 | 264 | 0.13 | 74 | 18.4 |
| AVG | 22.9 | 331 | 5.7 | 189 | 0.19 | 85 | 15.6 |
| MAX | 24.4 | - | 9.4 | 324 | 0.90 | 97 | 20.6 |
| MIN | 21.0 | - | 4.2 | 62 | 0.00 | 66 | 10.4 |
| TOT | | | | 5850 | 5.92 | | |

HGF-A MET

| DAY | TEMP | WD | WS | RAIN | RH | BP |
|---|---|---|---|---|---|---|
| 01 | 22.2 | 336 | 5.4 | 0.50 | 94 | 29.36 |
| 02 | 22.8 | 348 | 3.9 | 0.00 | 86 | 29.32 |
| 03 | 22.2 | 333 | 4.6 | 0.00 | 87 | 29.38 |
| 04 | 23.0 | 324 | 8.8 | 0.01 | 88 | 29.43 |
| 05 | 22.8 | 17 | 5.9 | 0.18 | 91 | 29.44 |
| 06 | 23.4 | 52 | 5.9 | 0.09 | 87 | 29.43 |
| 07 | 22.4 | 27 | 4.0 | 0.34 | 94 | 29.46 |
| 08 | 23.7 | 89 | 7.2 | 0.01 | 87 | 29.51 |
| 09 | 22.9 | 18 | 5.9 | 0.06 | 88 | 29.56 |
| 10 | 22.4 | - | 6.2 | 0.34 | 89 | 29.51 |
| 11 | 21.3 | - | 5.1 | 0.34 | 95 | 29.45 |
| 12 | 22.4 | - | 5.1 | 0.16 | 85 | 29.41 |
| 13 | 22.8 | - | 4.3 | 0.17 | 90 | 29.44 |
| 14 | 23.2 | 30 | 5.2 | 0.15 | 94 | 29.46 |
| 15 | 23.2 | 3 | 4.6 | 0.04 | 92 | 29.31 |
| 16 | 23.6 | 57 | 4.1 | 0.09 | 88 | 29.22 |
| 17 | 23.7 | 140 | 6.9 | 0.51 | 97 | 29.25 |
| 18 | 23.9 | 85 | 7.0 | 0.42 | 93 | 29.25 |
| 19 | 24.4 | - | 5.2 | 1.15 | 96 | 29.40 |
| 20 | 23.6 | 54 | 4.3 | 0.69 | 94 | 29.50 |
| 21 | 23.6 | - | 5.4 | 0.09 | 90 | 29.51 |
| 22 | 22.6 | 5 | 4.6 | 0.05 | 92 | 29.51 |
| 23 | 22.6 | 25 | 5.7 | - | 92 | 29.44 |
| 24 | 22.2 | 18 | 4.3 | - | 96 | 29.44 |
| 25 | 22.8 | - | 4.4 | - | 89 | 29.48 |
| 26 | 23.2 | - | 4.9 | 0.02 | 91 | 29.46 |
| 27 | 23.1 | - | 7.0 | 0.09 | 90 | 29.48 |
| 28 | 23.2 | - | 11.2 | 0.01 | 76 | 29.49 |
| 29 | 23.3 | 14 | 8.1 | 0.18 | 87 | 29.52 |
| 30 | 22.9 | 32 | 6.9 | 0.01 | 83 | 29.51 |
| 31 | 22.2 | 355 | 7.8 | 0.00 | 82 | 29.47 |
| AVG | 22.9 | 27 | 5.8 | 0.20 | 90 | 29.43 |
| MAX | 24.4 | - | 11.2 | 1.15 | 97 | 29.56 |
| MIN | 21.3 | - | 3.9 | 0.00 | 76 | 29.22 |
| TOT | | | | 5.55 | | |

536

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**THERMAL POWER**
COMPANY

WATER & LAND DEVELOPMENT

STATE OF HAWAII

30 January 1984

Mr. Susumu Ono
Chairman
Board of Land Natural Resources
1151 Punchbowl Street
Honolulu, Hawaii 96813

Re: **Proposed Drilling**
**State Geothermal Mining Lease R-2**
**Puna District, Hawaii County**

Dear Mr. Ono:

Puna Geothermal Venture submits herewith an application for Permit to Drill on the referenced lease. This application is for a proposed replacement well, Kapoho State 1-A, to be drilled from the existing Kapoho State 1 well pad. This well will enable Thermal Power Company, as operator for PGV to perform flow tests which will identify the stabilized flow characteristics of the Puna geothermal resource.

Your early consideration and approval of the Permit to Drill for the proposed Kapoho State 1-A will be appreciated. Please contact Nicki Norman (415) 765-0446 if you have any questions or further requests regarding this application.

Very truly yours,

W. L. D'Olier
Vice President
Geothermal Exploration

WLD/tti

Enclosure: Application for Permit to Drill

601 California Street San Francisco California 94108 415-981-5700 Telex: 34387 NATOMAS SFO

RECEIVED

84 FEB 3 AM : 27

DIV. OF WATER &
LAND DEVELOPMENT

**PUNA GEOTHERMAL VENTURE**

**APPLICATION FOR PERMIT TO DRILL PROPOSED GEOTHERMAL WELL KAPOHO STATE 1-A ON RESERVED LANDS, KAPOHO, PUNA, HAWAII**

Complying with Regulation 8, Rule 9.1, Thermal Power Company as Operator for the Puna Geothermal Venture, herewith makes application for Permit to Drill for approval by the Hawaii Board of Land and Natural Resources.

a. Applicant:

Thermal Power Company
601 California Street
San Francisco, California 94108

Owner of Mining Rights:

Kapoho Land Partnership

Land Owner:

Kapoho Land and Development Company, Limited

THERMAL POWER COMPANY

By: W. L. D'Olier
W. L. D'Olier
Vice President
Geothermal Exploration

b. Proposed well designation: Kapoho State 1-A.

c. The enclosed tax key map, Exhibit A, designates the approximate location of the drillsite for Kapoho State 1-A located on State Geothermal Mining Lease R-2. The wellhead location will be surveyed by a registered surveyor upon completion of the geothermal well and removal of the drill rig.

d. The purpose of the additional exploratory drilling is to replace the Kapoho State 1 well which has obstructions in the wellbore preventing an accurate reading of full flow measurements. In addition, the reservoir data obtained thus far from limited flow tests of Kapoho State 1 and Kapoho State 2 shows unexpected differences from the data on the Hawaii Geothermal Project. Consequently, it will be necessary to obtain another data point on the reservoir to confirm the resource characteristics.

e. The drilling of Kapoho State 1-A will require approximately 70 drilling days to reach the maximum proposed depth of 7,500 feet. The expected production interval may be encountered below 4,100 feet. Upon completion of the well, a long flow test (maximum 3 months) will be performed. The proposed drilling and flow test will comply with all applicable State and County regulations, ordinances, and permits to mining any nuisance.

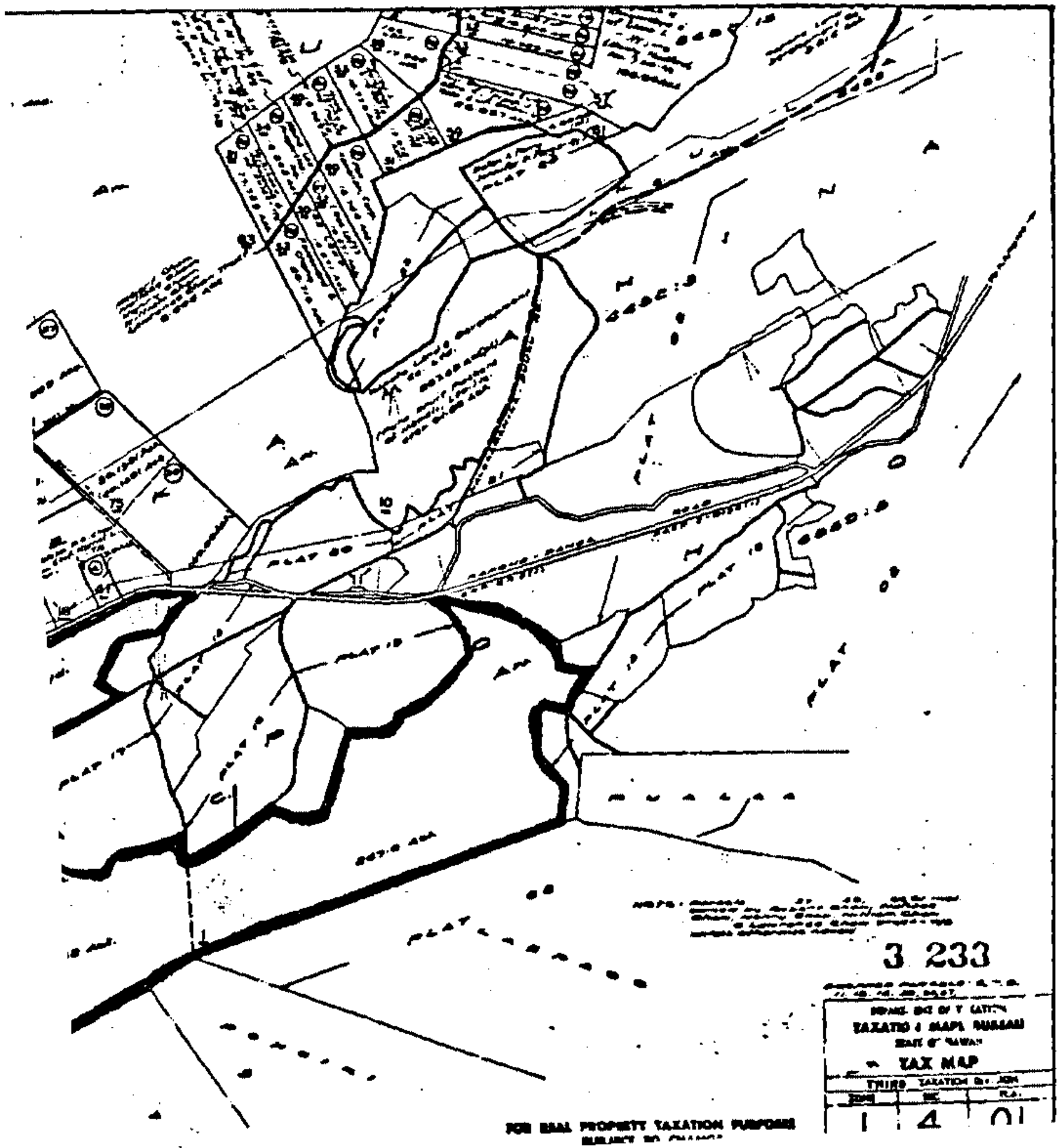
f. The Drilling and Completion Procedures, Drillsite Plan, and Vertical Section for Kapoho State 1-A are contained in Exhibits B, C, and D respectively.

g. A multi-well drilling bond ($250,000) has been filed with the State of Hawaii. The bond certification is attached as Exhibit E.

h. Thermal Power Company, as Operator for the Thermal-Dillingham-Amfac Joint Venture, agrees to perform such exploratory drilling as outlined in this application and agrees to maintain the well in accordance with Regulation 8, State of Hawaii and all Fedral and County geothermal regulations.

Attachments: $100 filing fee
Exhibits A, B, C, D, E

Submitted: January 1984



3 233
TAX MAP
1 4 01
FOR REAL PROPERTY TAXATION PURPOSES

THERMAL POWER COMPANY, OPERATOR

GEOTHERMAL WELL:
KAPOHO STATE 1-A

## PROPOSED DRILLING AND COMPLETION PROGRAM

1. Prepare second 10' x 10' x 10' cement-rebar wellhead cellar on existing location. Set 30" conductor pipe through cellar floor.

2. Move in Drilling Contractor's rig; drill and set rathole.

   (a) Notify Hawaii Board of Land and Material Resources (BLNR) 24 hours prior to commencement of drilling.

   (b) Confirm compliance with all permit requirements.

3. Spud hole with 12¼" bit and mud drilling fluid; drill to into top 20-feet of ground water zone in expected 600-700' depth interval. Stop and sample ground water.

4. Drill ahead to 1400' depth. Open 12¼" hole to 17½" and then to 26" Control lost circulation with LCM; cement severe lost circulation zones if required.

5. Run 20", 94 pound H-40 Buttress coupled casing to 1400'. Single stage Class G cement with 40% silica flour; use appropriate excess slurry. Be prepared to cement the 20-30" annulus with Redi-mix from the surface. W.O.C. 8 hours.

6. Land 20" casing. Weld on 21¼" 2000 psi wellhead.

   (a) Pressure test the weld.

   (b) Install B.O.P.E. consisting of a hydraulically-operated double ram blowout preventer with one set each of pipe and blind rams, an expansion-type annular preventer and a mud fillup line.

   (c) Notify the Chairman of the Hawaii Board of Land and Natural Resources (BLNR) in advance of B.O.P.E. test so that designated representative can witness the test.

   (d) Test each preventer, the stack, casing, kelly cock, master valve, check valves in kill line, and blowdown line valve to 1000 psig. Enter test results on contractor and operator daily reports.

7. Install mud logging service at shoe of 20" casing before drilling out. Record continuous mud in and out temperatures, $H_2S$, $CH_4$, $CO_2$, lithology, and drilling rate. Have pit level indicator and intercom to drillers station. Catch four sets of 50 gpm dry sample every 20'. Make daily copies of the mud log, keeping one (1) copy up to date and spliced in trailer. Send five copies to:

   THERMAL POWER COMPANY
   601 California Street
   San Francisco, California 94108
   Attention: Joe Iovenitti

8. Drill 17½" hole to 2700' depth with mud drilling fluid. Survey wellbore every 200' or on bit change.

9. Run 13 3/8", 61 pound C-90 VAM coupled casing to 2700', with DV collar at 2500'.

   (a) First stage 400 annular feet of Class G cement with 40% silica flour.

   (b) Open DV collar, circulate out excess cement. W.O.C. 24 hours.

   (c) Tension 13 3/8" casing with jacks and set extended casing in wellhead slips.

   (d) Second stage a low density spherelite cement through DV collar. Use appropriate excess slurry to obtain uncontaminated cement returns. Close DV tool with wiper plug.

10. Remove B.O.P.E. Stub the 13 3/8" casing and nipple up 21¼" 2000 psi x 13 5/8 3000 psi casing spool.

   (a) Pressure test the wellhead.

   (b) Install B.O.P.E. consisting of one 12" Series 400 gate valve, a 12" mud cross with two side outlets for a kill line and a choke manifold, a hydraulically-operated double ram blowout preventer with one set each of pipe and blind rams, a 12" expansion-type annular preventer, and a mud fillup line. A rotating head may be added as directed.

   (c) Notify the Chairman of the Hawaii Board of Land and Natural Resources (BLNR) in advance of B.O.P.E. test so that designated representative can travel to the site and witness the test.

   (d) Test each preventer, the stack, casing, kelly cock, master valve, check valves in kill line, and blowdown line valve to 1000 psig. Record results on contractor and operator's daily reports.

   (e) Confirm drillsite location and operation of all $H_2S$ safety equipment. Put all drillsite personnel through $H_2S$ safety review including equipment downing by each person.

   (f) Confirm kelly cock installation and operation between kelly and swivel.

11. Drill 12¼" hole to approximately 4100' depth with mud drilling fluid.

    (a) Survey hole at 500' intervals. Run maximum reading thermometers with each survey.

    (b) Continue mud logging as specified in 6(c) with special emphasis on temperature increases with depth.

12. Run 9 5/8", 47 pound, C-90, Hydril Triple Seal coupled production casing to bottom of 12¼" hole, with DV collar 200 feet above casing shoe.

    (a) Cool wellbore and first stage 400 annular feet of Class G cement with 40% silica flour.

    (b) Open DV collar, circulate out excess cement. W.O.C. 24 hours, cooling hole as directed.

    (c) Tension 9 5/8" casing with jacks and set extended casing in wellhead slips.

    (d) Second stage a low density spherelite cement through DV collar. Use appropriate excess slurry to obtain uncontaminated cement returns. Close DV tool with wiper plug.

13. Remove B.O.P.E. Stub the 9 5/8" casing as directed.

    (a) Install 13 5/8" x 11" 3000 psi expansion spool and 11" 3000 psi master valve.

    (b) Reinstall B.O.P.E. as in 10(b) above; notify BLNR as in 10(c) and test as in 10(d).

14. Drill 8 3/4" or 8½" hole, using fresh water as drilling fluid, to 6500 or 7500 foot total depth as directed. Flow testing of incremental intervals of production zone may be performed.

15. At total depth, hang or stand as directed, a drilled or slotted, 7", 26 pound, C-90, VAM coupled, production liner which is to be lapped 200 feet inside the 9-5/8" production casing.

16. Make a wireline run to bottom of 7" liner. Release rig and prepare for flow testing.

ATTACHMENT

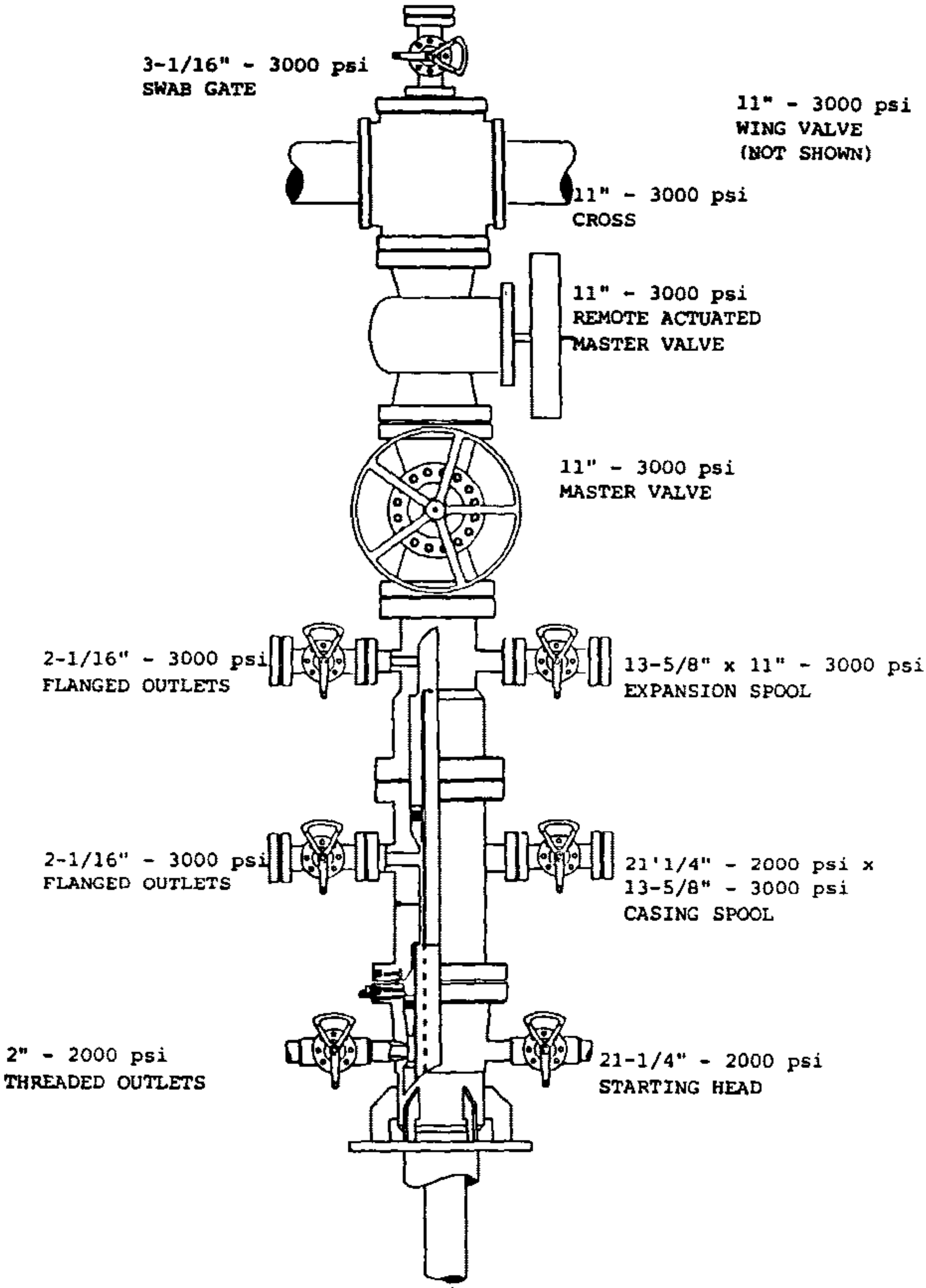



FIGURE 8

KAPOHO STATE #3 PROPOSED WELLHEAD DESIGN

THERMAL POWER
COMPANY

8 February 1984

Mr. Manabu Tagomori
Chief Water Resources and
Flood Control Engineer
Dept. of Land and
Natural Resources
1151 Punchbowl Street Rm. 227
Honolulu, Hawaii 96813

Dear Mr. Tagomori:

In a letter to Chairman Susumu Ono dated January 30, 1984, Thermal Power Company submitted a drilling permit application for a replacement well to be drilled from our existing KS-1 well pad. The well will be used to replace the existing KS-1 well in order to complete the resource testing needed to evaluate the Puna area geothermal resource. The attached drill site plan and vertical section, Attachments C and D respectively, are hereby submitted to supplement that application. Please feel free to call me at (415) 765-0446 if you or your staff have any questions regarding the application.

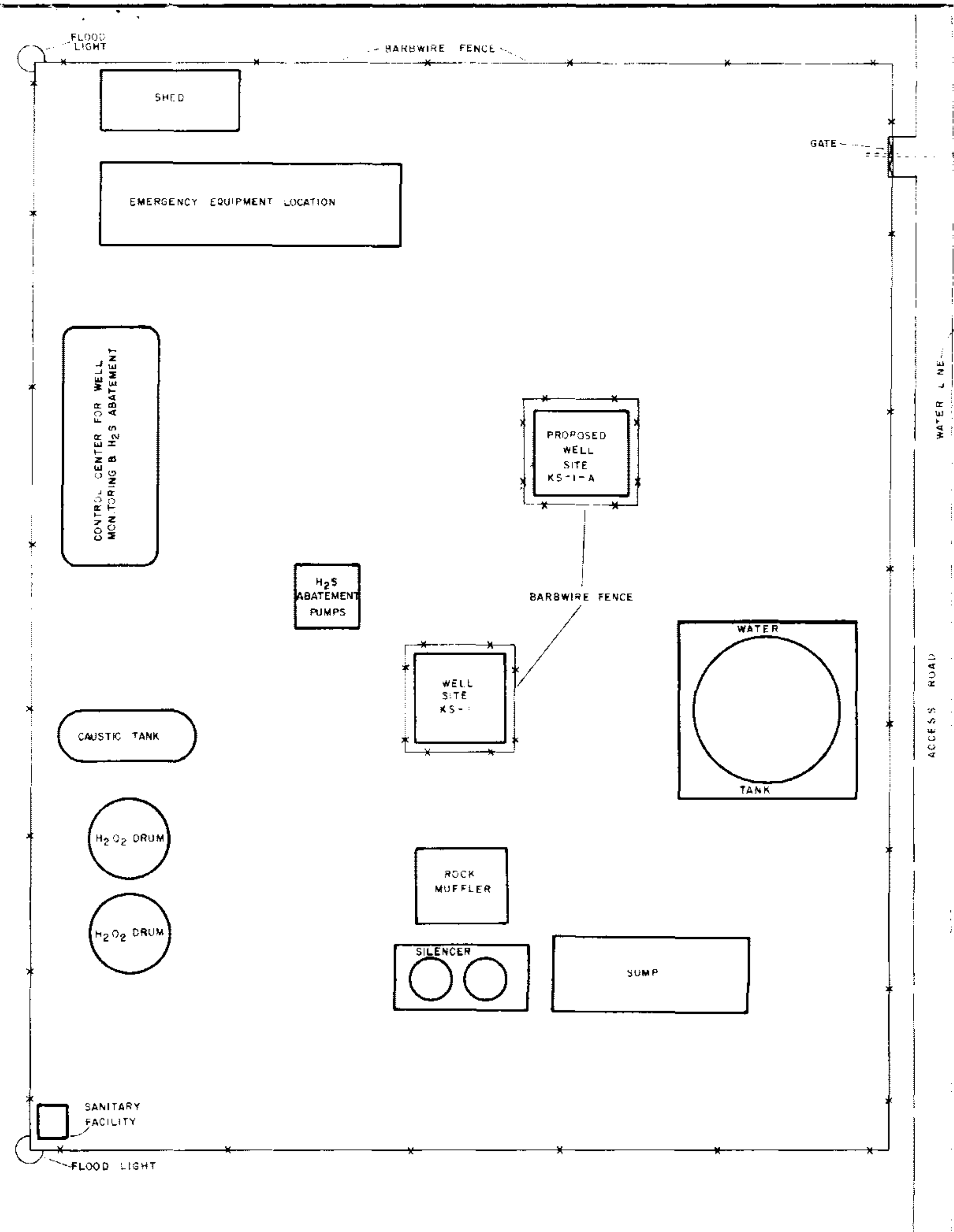
Very truly yours,

Nicki Norman/crn

Nicki Norman
Environmental/Regulatory Affairs
Project Coordinator

NAN/crn
attachments

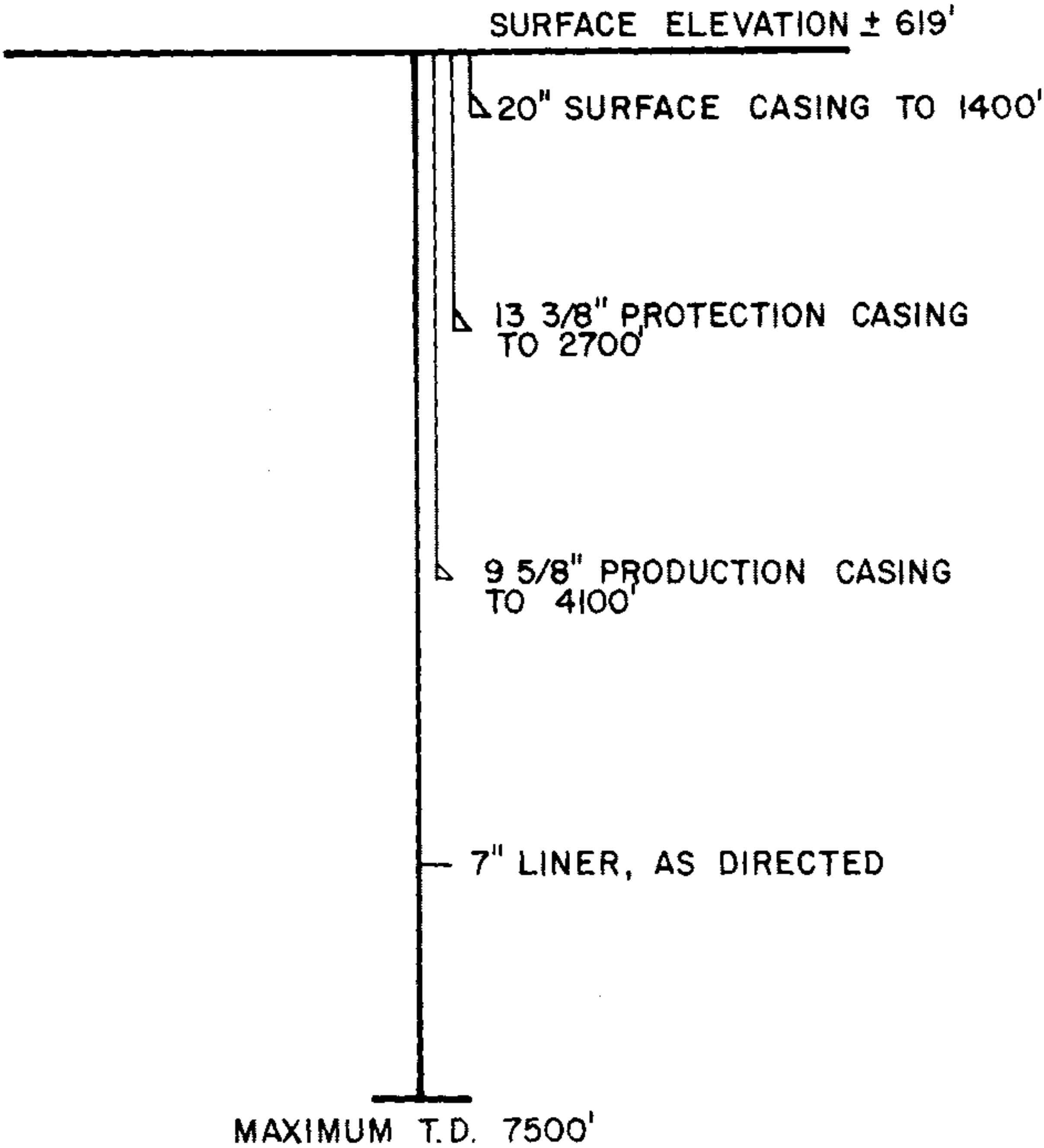
601 California Street San Francisco California 94108 415-981-5700 Telex: 34387 NATOMAS SFO




N.T.P.
1/11/84
NOT TO SCALE

# THERMAL POWER COMPANY
# KAPOHO STATE 1-A GEOTHERMAL WELL

## VERTICAL SECTION




1/30/84

CORPORATION

STATE OF HAWAII,
City and County of Honolulu } ss.

*On this* 18th *day of* March, *A. D. 19* 81 *before me appeared*
Kazu Hiramoto
*to me personally known, who, being by me duly sworn, did say that* ~~they are~~ he is *the*
Senior Vice President
*respectively of* Kazu Hiramoto
*and that the seal affixed to the foregoing instrument is the corporate seal of said corporation and that said instrument was signed and sealed in behalf of said corporation by authority of its Board of Directors, and the said* Kazu Hiramoto *acknowledged said instrument to be the free act and deed of said corporation.*

*Notary Public, First Judicial Circuit, State of Hawaii.*

*My Commission Expires* 12-20-81

STATE OF CALIFORNIA
County of Los Angeles } ss.

On this 17th day of March, 1981, before me, Carol G. Grasso, a notary public in and for the State of California with principal office in the County of Los Angeles, residing therein, duly commissioned and sworn, personally appeared Pamela L. Jacobs, known to me to be the person whose name is subscribed to the within instrument as the attorney-in-fact of the National Fire Insurance Company of Hartford, the corporation named as Surety in said instrument, and acknowledged to me that he subscribed the name of said corporation thereto as Surety, and his own name as attorney-in-fact.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed my official seal, at my office in the aforesaid County, the day and year in this certificate first above written.

OFFICIAL SEAL
CAROL G. GRASSO
NOTARY PUBLIC - CALIFORNIA
PRINCIPAL OFFICE IN
Los Angeles County
My Commission Expires Oct. 8, 1982

Carol G. Grasso
Notary Public

S-1157 5/70

[redacted]

[redacted]

BOND NO. 567 7792

# GEOTHERMAL RESOURCES WELL INDEMNITY BOND
($250,000 Statewide Well Bond)

KNOW ALL MEN BY THESE PRESENTS:

That we, Thermal Power Company, as principal; and NATIONAL FIRE INSURANCE COMPANY OF HARTFORD organized and existing under and by virtue of the laws of the STATE OF HAWAII and authorized to transact surety business in the STATE OF HAWAII, as surety, are held and firmly bound unto the State of Hawaii in the full and just sum of TWO HUNDRED FIFTY THOUSAND AND NO/100 DOLLARS ($250,000.00) lawful money of the United States of America, to be paid to the said State of Hawaii, for which payment, well and truly to be made, we do hereby bind ourselves, our heirs, executors, administrators, successors and assigns, jointly and severally, firmly by these presents.

Signed, sealed, delivered and dated this 17th day of March, 19 81.

THE CONDITION OF THE ABOVE OBLIGATION IS SUCH THAT,

WHEREAS, said principal is about to acquire, drill, redrill, deepen, operate, maintain or abandon a geothermal resources wells in the State of Hawaii and is required to file this bond in connection therewith in accordance with Rule 9.4 of Regulation 8 of the Department of Land and Natural Resources, State of Hawaii.

NOW, THEREFORE, if said THERMAL POWER COMPANY, the above bounden principal, shall well and truly comply with all the provisions of said Regulation 8 and shall obey all lawful orders of the Chairman of the Board of Land and Natural Resources, or his representative, if not appealed to the Board of Land and Natural Resources, or upon affirmance thereof by the Board of Land and Natural Resources, if appealed thereto, and shall pay all charges, costs, and expenses incurred by the Chairman or his representative, in respect of such well or the property or properties of said principal, or assessed against such well or the property or properties of such principal, in pursuance of the provisions of said Regulation 8, then this obligation shall be void; otherwise, it shall remain in full force and effect.

COUNTERSIGNED AT HONOLULU, HAWAII
FRANK B. HALL & CO. OF HAWAII, INC.
BY [signature]
KAZU HIRAMOTO
SENIOR VICE PRESIDENT
MAR 18 1981

THERMAL POWER COMPANY

By: [signature]
W. L. D'Olier
Vice President
Geothermal Operations

Approved as to form:

____________________
Deputy Attorney General

Dated: ________________

NATIONAL FIRE INSURANCE COMPANY OF HARTFORD Surety

By: [signature]
Pamela L. Jacobs
Its: Attorney-in-Fact

**Diamond Shamrock**
Thermal Power Company

**Ralph A. Patterson, Jr.**
Hawaii Project Manager

19 December 1984

Mr. Susumu Ono
Chairman
Board of Land and
Natural Resources
Kalanimoku Building
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Ono:

In accordance with the Department of Land and Natural Resources Administrative Rules, Title 13, Chapter 183-65 (7) (c), a 180 day extension of our geothermal drilling permit for the well designated Kapoho State #1-A, on DLNR Geothermal Resources Mining Lease R-2, is requested.

A permit to drill Kapoho State 1-A was issued by your office on 28 March 1984, based on the application filed by Thermal Power Company on 30 January 1984.

As outlined in the permit application, Kapoho State 1-A will be of a different design, using higher grade casing and couplings than in the Puna Geothermal Venture's previous exploratory wells at this site. Because of the limited number of suppliers of this casing, and our specifications for premium couplings which are only machined by a small number of manufacturers, the logistics of the casing purchase and delivery have caused us to delay the start of drilling.

Based on the casing and coupling delivery dates in Hilo, we now expect that we will begin drilling Kapoho State 1-A, in accordance with the previously approved program, during early April of 1985. Thus a 180 day extension of the drilling permit is requested.

Please contact me at the Honolulu office of Thermal Power Company if you or your staff have any questions about the above request.

Sincerely yours,

Ralph A. Patterson Jr

RAP/crn
cc: R. T. Pittenger, Thermal Power Co.
W. L. D'Olier, Thermal Power Co.
R. Chuck, Div. of Water & Land. Dev.

**Thermal Power Company**
A subsidiary of Diamond Shamrock, 1600 Kapiolani Boulevard, Suite 808, Honolulu, Hawaii 96814
Phone 808 944 5545

**Diamond Shamrock**
Thermal Power Company

1600 Kapiolani Boulevard, Suite 808
Honolulu, Hawaii 96814

PM
20 DEC
1984

MR. ROBERT CHUCK
Division of Water & Land Deve
Kalanimoku Building
1151 Punchbowl Street
Honolulu, Hawaii 96813

**Diamond Shamrock**
Thermal Power Company

**Ralph A. Patterson, Jr.**
Hawaii Project Manager

19 December 1984

Mr. Susumu Ono
Chairman
Board of Land and
Natural Resources
Kalanimoku Building
1151 Punchbowl Street
Honolulu, Hawaii 96813

Dear Mr. Ono:

In accordance with the Department of Land and Natural Resources Administrative Rules, Title 13, Chapter 183-56, the approval of the enclosed amendment to the Plan of Operation for the Puna Geothermal Venture, for which Thermal Power Company is the operator, is hereby requested.

The Plan of Operation covers the exploratory activities taking place on the lands covered by State Geothermal Mining Lease R-2.

If there are any questions, please direct them to me at the Honolulu office of Thermal Power Company.

Sincerely yours,

Ralph A. Patterson, Jr.

RAP/crn
encl

**Thermal Power Company**
A subsidiary of Diamond Shamrock, 1600 Kapiolani Boulevard, Suite 808, Honolulu, Hawaii 96814
Phone 808 944-5545